Navajo Nation
Western Navajo Pipeline Phase 1
LeChee Water System Improvements (WSI)

PROJECT MANUAL

VOLUME 2 OF 2

DIVISION 1 THRU 50 – TECHNICAL SPECIFICATIONS

Issue for Bid

NAVAJO NATION

August 2024

Brown and Caldwell
6975 Union Park Center, Suite 490
Midvale, UT 84047

PROJECT MANUAL

FOR CONSTRUCTION OF

Navajo Nation
WESTERN NAVAJO PIPELINE PHASE 1
LECHEE WATER SYSTEM IMPROVEMENTS (WSI)

Volume 2 of 2
Division 1 thru 50 – Technical Specifications

Navajo Nation

Prepared by:

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Project No. 150360

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WESTERN NAVAJO PIPELINE PHASE 1

LECHEE WATER SYSTEM IMPROVEMENTS (WSI)

ITEMS IN THIS PROJECT MANUAL	PREPARED BY
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	Steve Brenchley, P.E. Brown and Caldwell 6975 Union Park Center, Suite 490 Midvale, UT 84047
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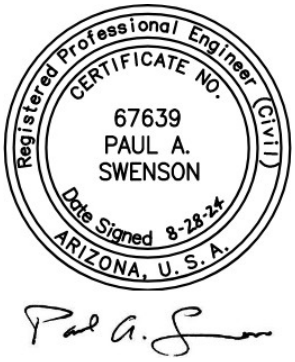	Paul Swenson, P.E. DOWL 222 N 32nd St, Suite 700 Billings, MT 59101

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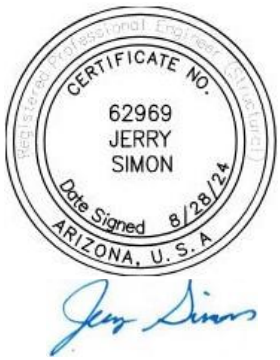	Jerry Simon, P.E. Brown and Caldwell 1527 Cole Blvd., Suite 300 Lakewood, CO 80401
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	Gregory Short, AIA Short and Brennan Architects One Broadway, Suite A201 Denver, CO 80203
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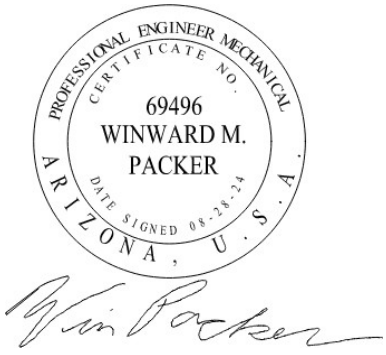	Win Packer, P.E. WHW Engineering LLC. 8619 Sandy Pkwy, Unit 101 Sandy, UT 84070

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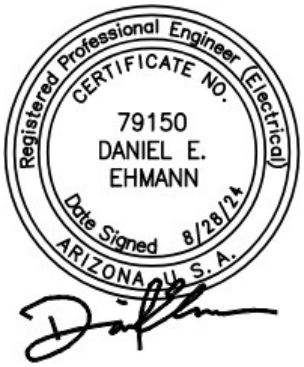	Daniel Ehmann, P.E. Brown and Caldwell 2 N. Central Avenue, Suite 1600 Phoenix, AZ 85004
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LECHEE WATER SYSTEM IMPROVEMENTS (WSI)

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SECTION 01 11 00

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

A. The work include in this contract will be performed at the site of the existing Lake Powell Water Intake Facility; the proposed LeChee Water Treatment Plant (WTP) site located just west of the previous Navajo Generating Station (NGS) site; and a proposed Booster Pump Station site, located south of the intersection of Navajo Highway N-222 and State Route 98 (SR-98). This project also includes the installation of a pipeline from the new water treatment plant to the existing water storage tanks at the Lechee Community Water System operated by the Navajo Tribal Utility Authority (NTUA).

1.02 DESCRIPTION OF OWNER'S PROJECT

A. The LeChee Water Improvements project will provide additional water supply to the LeChee Water System. Water from Lake Powell will be pumped through a the existing intake facility, and discharge treated water to a new LeChee Booster Pump Station. The discharged water will travel through a new pipeline, where it will serve the LeChee System. The work to be performed under this contract includes: Procurement of materials and construction detailed in Volumes 1, 2, and 3 of the Western Navajo Pipeline Phase 1 design drawings. Volume 4 drawings contain the needed survey ROW needed for construction of this project.

1.03 CONTRACTS – NOT USED

1.04 WORK OF THIS CONTRACT

A. The work to be performed under this contract (LeChee Water System Improvements (WSI)) includes:
   1. Lechee Intake Facility:
      a. Demolition of existing equipment at existing Lake Powell Intake Facility including the removal of existing submersible pumps and booster pumps,
      b. Install two new 700 gallon per minute (gpm) submersible and two 700 (gpm) booster pumps at existing Intake Facility,
      c. Construct new control building with site improvements, miscellaneous telemetry system and backup generator.
   2. Lechee Water Treatment Plant:
      a. Construct new 500,000-gallon raw water storage tank with meter and transducer vault,
      b. Construct new 1 million gallon per day (1 MGD) Membrane Water Treatment Plant Building that includes chlorine feed system room, electrical room, process mechanical room, and administrative office area.
      c. Construct new 320,000-gallon finished water tank,
      d. Construct settling basin structure,
      e. Construct solids settling vault and associated meter and valve vault,
      f. Construct storm water retention basin,

g. Construct chemical drying beds,
h. Construct and Install yard piping, site improvements, and miscellaneous telemetry items.

3. Lechee Pump Station No. 3 and Pipeline:
   a. Construct approximately 30,936 LF of 12-inch potable water line,
   b. Construct a 600 gpm Pump Station No. 3 and site improvements with miscellaneous telemetry items,
   c. Construct and install yard piping and connection to existing LeChee tanks with miscellaneous telemetry items.

END OF SECTION

SECTION 01 11 80

ENVIRONMENTAL CONDITIONS

PART 1 GENERAL

1.01 ENVIRONMENTAL CONDITIONS

A. This section describes the environmental conditions which have been observed at the site of the work and which may reasonably be anticipated throughout the life of the project.

1.02 CLIMATE CONDITIONS

A. The site of the work is at an elevation of 3730 to 4810 feet above mean sea level.

B. Climate conditions are described as follows:

Description	Range of Conditions
Winter	20 to 40 (°F)
Summer	44 to 110 (°F)
Relative humidity, percent	
• Indoors	40-60%
• Average outdoors	40-60%
Air temperature, degrees F	
• Outdoors	53.2 °F Annual Avg
• Indoors	70 °F (Varies)
Barometric pressure, inches, mercury	30.01 Annual Avg

1.03 ADDITIONAL CONDITIONS

A. Additional conditions which may be applicable are specified in other sections.

END OF SECTION

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SECTION 01 12 16

WORK SEQUENCE

PART 1 GENERAL

1.01 CONTINUITY OF SYSTEM OPERATIONS

A. The existing LeChee water system is currently and continuously providing potable water, and that function shall not be interrupted except as specified herein. The Contractor shall coordinate the work to avoid any interference with normal operation of water production, disinfection, and storage processes.

1.02 BYPASSING – NOT USED

1.03 SUBMITTAL

A. In accordance with Section 01 33 00, the Contractor shall submit a detailed outage plan and time schedule for operations which will make it necessary to remove a tank, pipeline, channel, electrical circuit, equipment, or structure from service. The schedule shall be coordinated with the construction schedule specified in the General Conditions of the Contract Documents and shall meet the restrictions and conditions specified in this section.

B. The Contractor shall observe the following restrictions:
   1. Systems or individual equipment items shall be isolated, dewatered, decommissioned, deenergized, or depressurized in accordance with the detailed outage plan and schedule.
   2. The Resident Project Representative (RPR) and Construction Manager shall be notified in writing at least one week in advance of the planned operation.

1.04 SEQUENCE AND SCHEDULE OF CONSTRUCTION

A. To permit continuous production and disinfection of water and compliance with water quality requirements, the construction schedule required in in the General Conditions of the Contract Documents shall provide for the following specific conditions:
   1. Installation and modification of various control systems within this project will not impact system and not require temporary partial shutdown of these systems. Work shall be planned and scheduled in advance in order to minimize downtime.
   2. To facilitate the required temporary modifications to allow the existing water distribution system to continue during construction of the work of this project, the Contractor shall coordinate with the Owner and Engineer.
   3. The existing Intake facility shall be modified as shown on the Volume 1 drawings and in the specifications and be commissioned to deliver raw water through the existing 30-inch bar wrapped concrete pipe to the proposed water treatment plant raw water tank. The proposed Telemetry PLC at the new control building at the intake facility shall obtain tank level information from the this new raw water tank and provide start/stop control of the new booster pumps and submersible pumps that are installed at the existing intake facility building.
   4. The proposed LeChee Water Treatment Plant shall be built as shown on the Volume 2 drawings and in the specifications and be commissioned to deliver disinfected

potable water to the proposed water distribution system downstream of the water treatment plant. An approval for disinfection shall be obtained prior to the disinfection process. The telemetry PLC at the new water treatment plant shall obtain tank level information form the new finished water tank on site and provide start stop control of the water treatment plant.

5. The proposed LeChee Pump Station No. 3 and pipeline shall be built as shown on the Volume 3 drawings and in the specifications. The Boosterpaq and piping shall be tested, disinfected, and made operational prior to modification of the system telemetry operation. An approval for disinfection shall be obtained prior to the disinfection process.
6. The new connections to the existing LeChee Water Storage Tanks No. 1 and No. 2 will be performed sequentially so that one tank can remain in service at all times during the work. To accomplish each tank tap, the tank shall be drained, inspected, cleaned, and disinfected per AWWA C652 requirements before being put back in service.
7. The LeChee Pump Station No. 3 telemetry PLC shall obtain the tank level information from the existing LeChee Tanks No. 1 and No. 2 and provide start/stop control of the pump station.

END OF SECTION

SECTION 01 29 00

MEASUREMENT AND PAYMENT

1.GENERAL

1.01 SUMMARY

A. This Section specifies requirements for determining Contractor payments.

1.02 SCHEDULE OF VALUES

A. The Contractor shall submit a detailed Schedule of Values for the Work of the Contract, including quantities and unit prices aggregating the Contract Price, for approval in accordance with Article 2 of the General Conditions - Section 00700.

B. If any unit price in the approved Schedule of Values requires that the said unit price cover and be considered compensation for certain work or material essential to the item, this same work or material will not also be measured or paid for under any other pay item which may appear elsewhere in the Specifications.
   1. Schedule shall be listed in tabular form and include the following:
      a. Schedule item numbers.
      b. Schedule item descriptions.
      c. Unit cost description, bid quantity, bid unit cost, bid total amount per item.
      d. Estimated quantities for previous period, current application period, and total to date per item.
      e. Amount previously billed, amount billed this period, total amount billed and percent completion per item.
   2. Include a proportional amount of CONTRACTOR's overhead and profit for each item.
   3. If progress payments will be requested for materials or equipment stored either on or off site, show the following:
      a. Cost of the materials, delivered and unloaded, with taxes paid.
      b. Total installed value.

C. Upon request, submit documentation to support the values assigned to the Work. Sum of all values shall equal the TOTAL BID.

D. Schedule will be reviewed by the Engineer.
   1. Upon approval by the Engineer, the schedule will become the official reporting form upon which Application Payment will be calculated.
   2. Provide additional breakdown of bid item costs if requested by the Engineer.
   3. Failure to submit this schedule or receive approval may result in withholding of approval of Application for Payment.

1.03 MEASUREMENT OF QUANTITIES

A. Construction Manager Work completed under the Contract shall be measured according to the standards of weights and measures recognized by the U.S. Bureau of Standards.

B. The method of measurement and computations to be used in determination of quantities of material furnished and of work performed under the Contract will be those methods generally recognized as conforming to good engineering practice.

C. Measurement for area computations will be made on the surface. Pay measurements for area computations will not exceed the neat dimensions indicated on the Contract Drawings, unless otherwise ordered in writing by the Construction Manager.

D. Structures will be measured according to neat lines indicated on the Contract Drawings or as altered to fit field conditions. No payment will be made for length, width, or depth, in excess of that indicated on the Contract Drawings or specified for any construction, unless otherwise approved by the Construction Manager in writing.

E. Items which are measured by the linear foot, such as pipe, will be measured parallel to the base or foundation upon which such items are placed.

F. In computing volumes of excavation (when part of a unit price project component), the average end area method, based on horizontal measurements, or other acceptable methods, will be used. If the excavation is incidental or part of a lump sum bid item, no additional payments will be made.

G. The term "each", when used as an item of payment, will mean complete payment for the Work described in the payment item in the Contract Documents. The work described is not intended to be exhaustive.

H. The term "lump sum", when used as an item of payment, will mean complete payment for the Work described in the Contract Documents, including all necessary fittings and accessories, and required testing completed.

I. The term “complete in place”, means the completion of the Contract item or portions thereof as determined by the Construction Manager including the furnishing of all materials, equipment, tools, labor, and work incident thereto, unless otherwise specified.

J. Contingent unit price items work is work not shown on the Contract Drawings and shall be performed only at the direction of the Construction Manager.

1.04 SCOPE OF PAYMENT

A. The Contractor will receive and accept compensation provided for in the Contract Documents as full payment for furnishing materials, labor, tools, and equipment and for performing Work under the Contract in a complete and acceptable manner and for all risk, loss, damage, or expense of whatever character arising out of the nature of the Work or the execution thereof, subject to the provisions of the General Conditions.

B. Mobilization/Demobilization: Item A1:

1. When included in the Contractor's Schedule of Values, mobilization shall consist of the assembling and setting up for the project, the Contractor's necessary general plant, including Contractor's offices, Construction Manager/Resident Project Representative field office, shops, plants, storage areas, sanitary and any other facilities, as required by the Specifications and special requirements of the Contract, as well as by local or State law and regulation. The determination of the adequacy of the Contractor's facilities,

except as noted above, shall be made by the Contractor. The cost of required insurance and bonds and/or any other initial expense required for the start of Work will be included in this item. The Contractor shall furnish all materials and furnishings required, and these materials and furnishings will not be considered as part of the other various items of the completed Contract.

2. No additional payment will be made for demobilization. Costs for demobilization shall be included in this item.
3. Mobilization will be paid at the approved lump sum price for mobilization and demobilization included in the Contractor's Schedule of Values. The lump sum price for this item shall be payable to the Contractor in accordance with the following schedule:
    a. On the first monthly application for Progress Payment, the amount approved for mobilization or three percent of the total Contract Price, excluding the price for this item, whichever is less, will be paid.
    b. Whenever Work performed equals 25 percent of the total Contract Price excluding the approved price for this item, any remaining amount for mobilization, or an additional two percent of the total Contract Price excluding the approved price for this item, whichever is less, will be paid.
    c. Upon completion of the Project, any remaining amount approved for mobilization will be paid.

C. Contract Bond and Insurance: Item A2:
1. Contract Bond is defined as an approved form of security, executed by the Contractor and their surety or sureties, which guarantees performance of the work in accordance with the contract and all supplemental agreements, pertaining thereto, and the payment of all legal debts pertaining to the construction of the project. The Contract Bond shall be in effect during the full term of CONTRACTOR'S warranty period which is one (1) year from the date of substantial completion. This item shall also include the CONTRACTOR'S liability and property insurance as required in the modifications to the General Conditions.
2. At the time of the execution of the contract, the successful Bidder shall furnish a surety for a performance bond and for a labor and materials bond, in an amount equal to the full amount of the contract. The liability and property insurance shall also be submitted at the time of contract execution. To receive payment for the contract bond and insurance, the successful Bidder shall comply with the following requirements:
    a. Subsequent to award of the contract and satisfactory compliance with the above, the successful Bidder shall submit a written request to the OWNER requesting payment of the Contract Bond Bid and Insurance bid item. The successful Bidder shall include with this written request, a statement from the insuring firm, indicating the cost of the contract bonds based on the preliminary estimate of the cost of the contract and how that cost will be adjusted based on the final cost.
    b. Measurement shall be lump sum with payment for the Contract Bonds and Insurance bid item to be the actual cost with no CONTRACTOR'S markup (overhead and profit).

D. General Requirements: Item A3
1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for the requirements specified in the Division 1 General Requirements to include: attending and coordinating project meetings; coordination of submittals with the work; developing and maintaining and current project schedule;

arranging and contracting with a third party testing laboratory for testing in accordance with technical specifications; providing contractors utilities; implementing environmental controls; preparing and implementing of all Stormwater Pollution Prevention Plans and Permits; project identification signs; shipment protection and storage of equipment and materials; equipment and system performance and operational testing; commissioning of the project; training of NTUA operators on specific equipment and appurtenances; final cleanup and post construction repairs; maintaining and submitting record drawings; and providing operation and maintenance instructions.

E. Existing Intake Facility Demolition; Item B1:
   1. Measurement of this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for demolition of Pipes, Valves, Strainers, Fittings, Steel Tanks, Pumps, Guard Rail, at the intake site to make ready for installation of new pumps, building mechanical, and electrical and controls. Also included are any other work, materials, tools, equipment, labor, or other incidentals necessary to complete this item.

F. Site/Civil Including Structural Excavation and Backfill: Item B2:
   1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
      a. Includes clearing & grubbing, topsoil stripping, cut, engineered fill, rock excavation, shoring and bracing, haul, dewatering, backfill, compaction, surface restoration, topsoil replacement and seeding, erosion control blanket, geo fabric, locating and crossing all adjacent utilities as well as final grading and reclamation.
      b. Access/parking area – grading, subgrade preparation, compaction, exterior concrete, furnishing and placing the crushed base surfacing, asphalt paving, pavement markings, bollards, and wheel stops.
      c. Also included are any other work, materials, tools, equipment, erosion protection, labor, or other incidentals necessary to complete this item.

G. Control Building and Generator Pad Structural: Item B3:
   1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
      a. Scaffolding, Footings, Concrete Forms, Form Oil, Reinforcing Steel, Concrete, Equipment Pads, Masonry Walls, Grout, Bond beams, Anchor Bolts, Shoring and Bracing, and Structural Steel – Beams/Girders
      b. Also included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

H. Control Building Architectural: Item B4:
   1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall

include full compensation for furnishing and installing all materials and equipment associated with this item including:

a. Standing Seam Metal roof, Insulation, flashings, drip edge, fascia, soffit, gutters, downspouts, splash blocks, Doors and Hardware, Coatings
b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

I. Control Building HVAC: Item B5:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. HVAC Ductwork, Controls, HVAC AC/heating Units, and Balancing
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

J. Control Building Electrical and Instrumentation: Item B6:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Furnishing and installing all electrical and controls components associated with this building including PLCs, VFDs, panels and antennas; and coordination with and connection to the local electrical utility;
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

K. Control Building Standby Generator: Item B7:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Furnishing and installing the generator and associated fuel tank.
   b. Furnishing and installing all electrical and controls components associated with this generator including automatic transfer switch.
   c. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

L. 8-foot Chain Link Fencing and Gate: Item B8:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. 8-foot chain link fencing, with serpentine razor wire, gate, signs, etc.
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

M. Electrical Site Plan: Item B9:
   1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
      a. Furnishing and installing all electrical and controls, conduit, and components associated between the control building and the existing intake structure.
      b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

N. Booster Pump Skid Structural Pad: Item B10:
   1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
      a. The complete pump skid concrete pad; all of its components including the concrete, rebar reinforcement, epoxy, and all other accessories, fasteners, and appurtenances required for the satisfactory installation;
      b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

O. Grundfos Booster Pump Skid: Item B11:
   1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
      a. The complete Grundfos Boosterpaq skid; all of its components including the pumps, valves, inlet and outlet manifolds, pressure transducers, and dismantling joints.
      b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

P. Grundfos Submersible Pumps: Item B12:
   1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
      a. The complete Grundfos Submersible Pumps; all of its components including the reuse of existing pipe, flange rollers, and shafts.
      b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

Q. Quagga Mussel Chemical Feed Equipment: Item B13:
   1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

a. The complete Quaagga Mussel Chemical Feed Equipment; all of its components including the pump, tank, and piping
b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

R. Existing Intake Facility Process Mechanical Piping: Item B14:
1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. All pipe, valves, meter, fittings, necessary for the completion of connecting the existing piping to the proposed booster pump skid.
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

S. Existing Intake Facility Electrical and Instrumentation: Item B15:
1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Furnishing and installing all electrical and controls, and components connecting to the submersible pump and motor; as well as the check out, startup and training on the pumps and controls, and providing O&M manuals and factory certifications;
   b. Furnishing and installing all electrical and controls, and components connecting to the Boosterpaq pump motors; as well as the check out, startup and training on the pumps and controls, and providing O&M manuals and factory certifications;
   c. Furnishing and installing all electrical and controls, and components connecting to the Quagga Mussell pump motors; as well as the check out, startup and training on the pumps and controls, and providing O&M manuals and factory certifications;
   d. Furnishing and installing all electrical and controls, and components connecting to the existing exhaust fans, heaters, and proposed lighting.
   e. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

T. Water Treatment Plant Site/Civil: Item C1:
1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Includes clearing & grubbing, topsoil stripping, ripping rock, cut, engineered fill, excavation, shoring and bracing, haul, dewatering, backfill, compaction, surface restoration, topsoil replacement and seeding, erosion control blanket, geo fabric, final grading and reclamation.
   b. Access/parking area – grading, subgrade preparation, and compaction.
   c. Also included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

U. Water Treatment Plant Structural Fill Under Footing: Item C2:
   1. Measurement for this item shall be made on cubic yard basis with the quantity determined for payment based on quantity of fill actually used based on the estimated unit price per cubic yard.

V. 30" Pipeline Connection: Item C3:
   1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
      a. Connection to existing 30" bar wrapped pipe as shown on drawing no. C-00-007 in LeChee Volume 2 drawings.
      b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

W. Yard Piping: Item C4:
   1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
      a. Piping, valves, fittings, air release valves, and appurtenances withing the water treatment plant fenced site to connect to the 12" pipeline and the 10" waterlines to and from the water treatment plant, raw water tank, finished water tank, settling basin structure (Area 40), Solids Settling Vault and associated precast valve and meter vault (Area 70), and chemical drying beds (Area 50).
      b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

X. HDPE Liner – Chemical Drying Beds: Item C5:
   1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
      a. Includes installation of HDPE liner.
      b. Also included are any other work, materials, tools, equipment, erosion protection, labor, or other incidentals necessary to complete this item.

Y. Septic Tank and Drain Field: Item C6:
   1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
      a. Includes installation of Septic Tank and Drain Field.
      b. Also included are any other work, materials, tools, equipment, erosion protection, labor, or other incidentals necessary to complete this item.

Z. Site Electrical and Instrumentation (Outside WTP Building): Item C7:
   1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
      a. Includes installation of Electrical and Site Instrumentation for Raw Water Tank, Finished Water Tank, Raw Water Meter and transmitter Vault, Solids settling vault and associated meter and valve vault, Settling Basin, and Chemical drying bed level measurement.
      b. Also included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

AA. 8-foot chain link fencing and gates: Item C8:
   1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
      a. 8-foot chain link fencing, with serpentine razor wire, gates, signs, etc.
      b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

BB. Gravel Surface: Item C9:
   1. Measurement for this item shall be made on a unit price basis with the quantity determined for payment based on the square foot of gravel surface completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
      a. Full depth base course and geofabric for gravel surface section detail.
      b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

CC. Site Concrete: Item C10:
   1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
      a. Waterway, concrete sidewalk.
      b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

DD. Asphalt Surface: Item C11:
   1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
      a. Compaction of subgrade, installation of geofabric, installation of road base, asphalt, and striping

b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

EE. Site Riprap: Item C12:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Compaction of subgrade and installation of rip-rap as shown on enlarged site plan C-00-201.
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

FF. Erosion Control: Item C13:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Silt fence, straw bales, or any other items used for erosion control including reseeding disturbed areas.
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

GG. Raw Water Meter Vault: Item C14:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Precast raw water meter vault including all interior mechanical piping, meter, pressure transducer, etc.
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

HH. Raw Water Welded-steel tank: Item C15:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. The welded steel tank as shown in IHS Standard Detail W-20 including the self-supported dome roof, vent pipe, support strap, overflow/weir box, hatch door, exterior caged ladder, fall arrest system, roof handrail, dollar plate w/formed rise, eave angle, liquid level indicator, overflow schedule 40 steel pipe, roof gore, target locator plate, stainless steel glass filled float, counterweight, varec cable connector, steel cable, tank internal and external coating, etc.
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

II. Raw Water Steel tank concrete foundation: Item C16:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
    a. The tank foundation including forming and placing concrete, concrete reinforcing steel; all associated inlet, outlet and drain piping and appurtenances required for the satisfactory installation.
    b. Also included are any other work, materials, tools, equipment, and labor or other incidentals necessary to complete this item.

JJ. Finished Water Welded-steel tank: Item C17:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
    a. The welded steel tank as shown in IHS Standard Detail W-20 including the self-supported dome roof, vent pipe, support strap, overflow/weir box, hatch door, exterior caged ladder, fall arrest system, roof handrail, dollar plate w/formed rise, eave angle, liquid level indicator, overflow schedule 40 steel pipe, roof gore, target locator plate, stainless steel glass filled float, counterweight, varec cable connector, steel cable, tank internal and external coating, etc.
    b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

KK. Finished Water Steel tank concrete foundation: Item C18:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
    a. The tank foundation including forming and placing concrete, concrete reinforcing steel; all associated inlet, outlet and drain piping and appurtenances required for the satisfactory installation.
    b. Also included are any other work, materials, tools, equipment, and labor or other incidentals necessary to complete this item.

LL. Process Mechanical Equipment and Piping: Item C19:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
    a. All pipe and mechanical equipment inside the water treatment plant building (Area 20) that is not already included in a vendor supplied equipment listed as separate items on the bid form, Pumps, Mixers, Pipe Penetrations, Fittings, Valves, Pipe taps, Compressed Air, Chemical Dosing Equipment, etc.
    b. The piping to the transition couplings outside of the building, including these couplings; tees, bends and valves between the couplings; restrained joint fittings and concrete encasement.

c. all associated piping and pipe spools; pressure gauges, pressure transducers, pressure switches, valves, hose bibs, flange adaptors, pipe stands and supports; air/vac valves, isolation valves, and magnetic flow meter.
d. Testing, flushing and disinfection of water treatment plant building piping, equipment, and appurtenances.
e. Also included are any other work, materials, tools, equipment, and labor or other incidentals necessary to complete this item.

MM. Water Treatment Plant Structural: Item C20:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Scaffolding, Footings, Foundation Stem Walls, Concrete Forms, Form Oil, Reinforcing Steel, Dowels, Concrete, Equipment Pads, Driveway and doorway aprons, Thickened Slabs, Sumps, Masonry Walls, Grout, Bond beams, Anchor Bolts, Pipe Encasement below building slab, Aluminum Grating, Shoring and Bracing, Bar Joist Roof, Steel Joists, Roof Decking, Foundation Over-Excavation and Backfill – Overburden.
   b. Also included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

NN. Water Treatment Plant Architectural: Item C21:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Standing Seam metal roofing, Doors and Hardware, Overhead Doors, Windows, drywall, Suspended Tile Ceiling, Floor Coatings, Wall Base, Wall Coatings, non-plumbing Bathroom Fixtures, Cabinets & Casework, and furniture
   b. Also included are any other work, materials, tools, equipment, and labor or other incidentals necessary to complete this item.

OO. Water Treatment Plant Plumbing: Item C22:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Copper piping, Black Steel Pipe, PVC pipe and fittings, floor drains, Plumbing Fixtures, Drain Pipe and fittings,
   b. Also included are any other work, materials, tools, equipment, and labor or other incidentals necessary to complete this item.

PP. Water Treatment Plant Electrical and Instrumentation: Item C23:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

a. All electrical, instrumentation and controls inside of the water treatment plant building (Area 20).
b. Also included are any other work, materials, tools, equipment, and labor or other incidentals necessary to complete this item.

QQ. Water Treatment Plant HVAC: Item C24:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. HVAC equipment including ground mounted roof-top units, Condensing unit, thermostats, heaters, fans, ductwork, etc.
   b. Also included are any other work, materials, tools, equipment, balancing, and labor or other incidentals necessary to complete this item.

RR. Membrane Filtration System: Item C25:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. This is a vendor supplied system with ultrafiltration (UF) water treatment system with blowers, Backpulse system, CIP system, Compressed air System, Chemical Feed, feed pump/filters, valves, etc.
   b. Also included are any other work, materials, tools, equipment, and labor or other incidentals necessary to complete this item.

SS. Water Treatment Plant GAC Contactor System: Item C26:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. This is a vendor supplied Granular Activated Carbon (GAC) System, complete with pipe and valves, skid mounted, etc.
   b. Also included are any other work, materials, tools, equipment, and labor or other incidentals necessary to complete this item.

TT. Water Treatment Plant Chlorine Gas Feed System and Containment: Item C27:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Chlorinator System with vacuum regulators, ejectors, booster pumps, chlorine gas detector, Chlorine Containment System, etc.
   b. Also included are any other work, materials, tools, equipment, and labor or other incidentals necessary to complete this item.

UU. Water Treatment Plant Backup Generator: Item C28:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Furnishing and installing the generator, associated fuel tank, and elevated platforms.
   b. Furnishing and installing all electrical and controls components associated with this generator including automatic transfer switch.
   c. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

VV. Water Treatment Plant Generator Pad: Item C29:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Cast in place concrete forms, reinforcing steel, structural concrete, footings, etc.
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

WW. Settling Basin Structure (Area 40): Item C30:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Cast in place concrete forms, reinforcing steel, structural concrete, footings, walls, etc.
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

XX. Process Mechanical Equipment and Piping Outside Water Treatment Plant Building: Item C31:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. All pipe and mechanical equipment outside the water treatment plant building (Area 20) that is not buried including Pumps, Mixers, Pipe Penetrations, Fittings, Valves, Gates, Pipe taps, etc.
   b. The piping to the transition couplings outside of the structures, including these couplings; tees, bends and valves between the couplings; restrained joint fittings and concrete encasement.
   c. all associated piping and pipe spools; pressure gauges, pressure transducers, pressure switches, valves, hose bibs, flange adaptors, isolation valves, etc.
   d. Also included are any other work, materials, tools, equipment, and labor or other incidentals necessary to complete this item.

YY. Solids Settling Vault and Associated Valve and Meter Vault (Area 70): Item C32:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Cast in place concrete forms, reinforcing steel, structural concrete, footings, walls, Precast concrete valve vault structure, etc.
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

ZZ. Lamella Plates: Item C33:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Stainless Steel Inclined Plate Settlers.
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

AAA. Site/Civil: Item D1

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Includes clearing & grubbing, topsoil stripping, cut, engineered fill, shoring and bracing, haul, backfill, compaction, surface restoration, topsoil replacement and seeding, erosion control blanket, geo fabric, locating and crossing all adjacent utilities as well as final grading and reclamation.
   b. Access/parking area – grading, subgrade preparation, compaction, exterior concrete, furnishing and placing the crushed base surfacing.
   c. Also included are any other work, materials, tools, equipment, erosion protection, labor, or other incidentals necessary to complete this item.

BBB. Gravel Surface: Item D2

1. Measurement for this item shall be made on a unit price basis with the quantity determined for payment based on the square foot of gravel surface completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Full depth base course and geofabric for gravel surface section detail.
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

CCC. 8-foot chain link fence and gates: Item D3:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

a. 8-foot chain link fencing, with serpentine razor wire, gates, signs, etc.
b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

DDD. Access Road fence and gate: Item D4:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Fence and gate as shown on drawing no. C-131 in LeChee Volume 3 drawings.
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

EEE. Yard Piping: Item D5:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Piping, valves, fittings, flush valves, and appurtenances withing the Booster Pump Station No. 3 fenced site to connect to the 12" pipeline and future upper antelope pipeline.
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

FFF. Pump Station Building Structural: Item D6:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Scaffolding, Footings, Concrete Forms, Form Oil, Reinforcing Steel, Concrete, Equipment Pads, Masonry Walls, Grout, Bond beams, Anchor Bolts, Shoring and Bracing, and Structural Steel – Beams/Girders
   b. Also included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

GGG. Pump Station Building Architectural: Item D7:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Standing Seam Metal roof, Insulation, flashings, drip edge, fascia, soffit, gutters, downspouts, splash blocks, Doors and Hardware, Coatings
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

HHH. Pump Station Process Mechanical Piping: Item D8:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid

item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:

a. All pipe and mechanical equipment inside the Pump Station No. 3 building including Pipe Penetrations, Fittings, Valves, Pipe taps, etc.
b. The piping to the transition couplings outside of the building, including these couplings; bends and valves between the couplings; restrained joint fittings and concrete encasement.
c. all associated piping and pipe spools; pressure gauges, pressure transducers, pressure switches, valves, hose bibs, flange adaptors, pipe stands and supports; air/vac valves, isolation valves, and magnetic flow meter.
d. Testing, flushing and disinfection of pump station building piping, equipment, and appurtenances.
e. Also included are any other work, materials, tools, equipment, and labor or other incidentals necessary to complete this item.

III. Grundfos Booster Pump Skid: Item D9:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. The complete Grundfos Boosterpaq skid; all of its components including the pumps, valves, inlet and outlet manifolds, pressure transducers, and dismantling joints.
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

JJJ. Surge Tank: Item D10:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. A 350 psi 300 gallon bladder type surge tank.
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

KKK. Electrical and Instrumentation: Item D11:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. All electrical, instrumentation and controls at the pump station building No. 3 site.
   b. Also included are any other work, materials, tools, equipment, and labor or other incidentals necessary to complete this item.

LLL. Building HVAC: Item D12:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall

include full compensation for furnishing and installing all materials and equipment associated with this item including:

a. HVAC Ductwork, Controls, HVAC AC/heating Units, and Balancing
b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

MMM. Yard Piping: Item E1:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Piping, valves, fittings, hydrant, and appurtenances withing the existing LeChee Tank site as shown on sheet C-120 of LeChee Volume 3 drawings to connect the new 12" pipeline to the existing LeChee Tanks.
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

NNN. Steel Tank Connection: Item E2:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. This item requires first connecting to the existing tank that is currently off line, disinfecting this tank and putting this tank in service prior to draining the smaller tank and connecting to this tank. Then isolate and connect the new line and disinfect the smaller tank prior to putting this tank back into service.
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

OOO. Electrical and Instrumentation: Item E3:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. a. modifying and installing all electrical and controls components associated with this tank as shown on the electrical and instrumentation drawings.
   b. Also included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

PPP. Traffic Control: Item F1:

1. The project traffic control will be paid for on a lump sum basis which is to be full compensation for furnishing a traffic control maintainer person, traffic control devices, such as signs barricades, barrels, cones, escort vehicle(s), two-way radios, and any other tools and equipment needed.

QQQ. Erosion Control: Item F2:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall

include full compensation for furnishing and installing all materials and equipment associated with this item including:

a. a. This item includes all silt fence, straw wattles, reseeding, etc. needed for erosion control for installation of the waterline pipeline.
b. Also included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

RRR. Asphalt Removal and Replacement: Item F3:

1. Measurement for this item shall be made on a lump sum basis with the quantity determined for payment based on the percentage of work completed under this bid item, as estimated by the ENGINEER at the time of the pay request. Payment shall include full compensation for furnishing and installing all materials and equipment associated with this item including:
   a. Removal and proper disposal of existing asphalt. Compaction of subgrade, installation of geofabric, installation of road base, and asphalt.
   b. Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

SSS. 12-inch C-900 DR25 PVC Pipeline: Item F4:

1. This item shall be measured in the field with quantity for payment based on actual lineal footage of PVC piping installed, which price shall include all trench excavation up to an 8.0’ depth as measured from the top of pipe (minimum bury for all areas shall be 3'-6" to top of pipe), stabilization, pipe, bends, thrust restraint at all fittings (thrust blocks or restrained joints per manufacturers recommendations), bedding/backfill, compaction, surface restoration (Topsoil stripping and replacement); traffic control; removal and replacement of all gravel on driveways and road surfaces, fences, and other features; shoring, dewatering, trench backfill, clearing and grubbing, tree removal, buried warning tape; crossing privately owned utilities, repair or replacement of damaged utility lines; testing, flushing and disinfection; furnishing and installing the pipe; erosion protection to include fertilizing, seeding, and mulching of all disturbed areas; and all materials, tools, equipment, labor and performance of all work necessary or incidental for completion of these items.
2. Pipe length shall be as measured through valves and fittings, unless otherwise stated.

TTT. 12-inch C-900 DR18 PVC Pipeline: Item F5:

1. This item shall be measured in the field with quantity for payment based on actual lineal footage of PVC piping installed, which price shall include all trench excavation up to an 8.0’ depth as measured from the top of pipe (minimum bury for all areas shall be 3'-6" to top of pipe), stabilization, pipe, bends, thrust restraint at all fittings (thrust blocks or restrained joints per manufacturers recommendations), bedding/backfill, compaction, surface restoration (Topsoil stripping and replacement); traffic control; removal and replacement of all gravel on driveways and road surfaces, fences, and other features; shoring, dewatering, trench backfill, clearing and grubbing, tree removal, buried warning tape; crossing privately owned utilities, repair or replacement of damaged utility lines; testing, flushing and disinfection; furnishing and installing the pipe; erosion protection to include fertilizing, seeding, and mulching of all disturbed areas; and all materials, tools, equipment, labor and performance of all work necessary or incidental for completion of these items.
2. Pipe length shall be as measured through valves and fittings, unless otherwise stated.

UUU. 12-inch C-900 DR18 PVC Pipeline Restrained Joint: Item F6:

1. This item shall be measured in the field with quantity for payment based on actual lineal footage of PVC piping installed, which price shall include all trench excavation up to an 8.0' depth as measured from the top of pipe (minimum bury for all areas shall be 3'-6" to top of pipe), stabilization, pipe, bends, bedding/backfill, compaction, surface restoration (Topsoil stripping and replacement); traffic control; removal and replacement of all gravel on driveways and road surfaces, fences, and other features; shoring, dewatering, trench backfill, clearing and grubbing, tree removal, buried warning tape; crossing privately owned utilities, repair or replacement of damaged utility lines; testing, flushing and disinfection; furnishing and installing the pipe; erosion protection to include fertilizing, seeding, and mulching of all disturbed areas; and all materials, tools, equipment, labor and performance of all work necessary or incidental for completion of these items.
2. Pipe length shall be as measured through valves and fittings, unless otherwise stated.

VVV. 12-inch C-900 DR14 PVC Pipeline: Item F7:

1. This item shall be measured in the field with quantity for payment based on actual lineal footage of PVC piping installed, which price shall include all trench excavation up to an 8.0' depth as measured from the top of pipe (minimum bury for all areas shall be 3'-6" to top of pipe), stabilization, pipe, bends, thrust restraint at all fittings (thrust blocks or restrained joints per manufacturers recommendations), bedding/backfill, compaction, surface restoration (Topsoil stripping and replacement); traffic control; removal and replacement of all gravel on driveways and road surfaces, fences, and other features; shoring, dewatering, trench backfill, clearing and grubbing, tree removal, buried warning tape; crossing privately owned utilities, repair or replacement of damaged utility lines; testing, flushing and disinfection; furnishing and installing the pipe; erosion protection to include fertilizing, seeding, and mulching of all disturbed areas; and all materials, tools, equipment, labor and performance of all work necessary or incidental for completion of these items.
2. Pipe length shall be as measured through valves and fittings, unless otherwise stated.

WWW. Wash Crossing Horizontal Directional Bores: Items F8 Through F10:

1. Measurement and Payment for Horizontal Directional drilling is explained in Part 4 of specification 33 05 07.13

XXX. Navajo Route 20 Road Crossings: Items F11 and F16:

1. Measurement and Payment for Navajo Route 20 Road Crossings will be made after each successful Jack and Bore and installation of casing pipe and installation of PVC pipe in casing across each highway crossing.

YYY. Residential Road Crossings: Items F12 Through F15:

1. Measurement and Payment for Residential Road Crossings will be made after each successful trench with casing and PVC pipe in casing across each residential road crossing has been installed.

ZZZ. Arizona State Road SR-98 Road Crossing: Item F17:

1. Measurement and Payment for Navajo Route 20 Road Crossings will be made after each successful Jack and Bore and installation of casing pipe and installation of PVC pipe in casing across each highway crossing.

AAAA. Antelope Canyon Tour Road Crossing: Item F18:

1. Measurement and Payment for this road crossing will be made after the successful trench with casing and PVC pipe in casing across this road has been installed.

BBBB. Navajo Route 222 Road Crossing: Item F19:

1. Measurement and Payment for Navajo Route 222 Road Crossings will be made after successful Jack and Bore and installation of casing pipe and installation of PVC pipe in casing across this highway crossing.

CCCC. Imported Backfill: Item F20:

1. Where imported backfill is required for the pipeline embedment zone and initial backfill to meet the requirements specified in the drawings and Section 02200 (Earthwork), it shall be as measured by delivery tickets and paid based on the tonnage of material delivered.

DDDD. 12" Gate Valve: Item F21:

1. These items shall be measured in the field with quantity for payment based on actual number of valves and fittings installed. Price shall include all trench excavation to depths indicated, bedding/backfill; traffic control; shoring, dewatering, all surface restoration, compaction, surface restoration, thrust blocking, cad-welds, anodes, restrained joints if necessary, testing and disinfection; furnishing and installing the materials; valve boxes and covers, marker posts (marked accordingly) and all materials, tools, fittings, equipment, labor and performance of all work necessary or incidental for completion of these items.

EEEE. 2-inch Flush Valve Assembly: Item F22:

1. Measurement for this item shall be made in the field with the quantity for payment determined by the actual number of flush valve assemblies installed. For the purpose of measurement and payment, a flush valve assembly shall be defined to include all 2-inch piping from the connection to the water main, the 2-inch gate valve with box, and tee on the main. Payment for a flush valve assembly shall be made at the contract price per each. Price shall include furnishing and installing the tee, 2-inch pipe, 2-inch gate valve w/box, all trench excavation, shoring, dewatering, backfill, compaction, thrust blocking, washed gravel, filter fabric, tie rods, marker post, testing and disinfection, surface restoration, furnishing and installing each flush valve assembly, and all materials, tools, equipment, labor and performance of all work necessary or incidental for the completion of this item in accordance with the Contract Documents.

FFFF. Combination Air Valve Assembly: Item F23:

1. Measurement for this item will be made in the field with the quantity for payment determined by the actual number of air/vacuum assemblies installed. Payment for this item will be made at the contract unit price per each. Price shall include furnishing and installing the combination air/vacuum valve, the curb stop valve, saddle, pipe, valves, marker post (marked accordingly),and fittings. Payment will also include the 36" meter box, lid, washed gravel floor, and all labor, equipment, tools, all excavation, backfill compaction, dewatering, final grading, sheeting, shoring, and incidentals required to complete this item in accordance with the Contract Documents.

2.**PRODUCTS – NOT USED**

3.**EXECUTION – NOT USED**

END OF SECTION

SECTION 01 31 19

PROJECT CONTROL

PART 1 GENERAL

1.01 PRECONSTRUCTION CONFERENCE

A. The Contractor will schedule and conduct a preconstruction conference prior to the commencement of any work at the site, to which all interested agencies and utility companies will be invited to discuss their interests and requirements relating to the project. Contractor and all subcontractor representatives shall attend.

1.02 CONSTRUCTION PERIOD MEETINGS

A. LANE CLOSURE: Lane closure shall be defined as denying any lane or any portion of a lane to traffic. A lane reduced to less than 11 feet is considered a lane closure.

1.03 REFERENCES

A. Construction period meetings will be conducted at weekly intervals or at some other frequency if approved by the Contractor and Engineer's Resident Project Representative (RPR). These meetings shall be attended by the RPR, Engineer's Construction Manager, the Contractor's Project Manager, Site Superintendent, and any others that are invited.

B. The Contractor will host a monthly construction meeting on site at their construction trailer. This meeting will be attended by the Engineer's Construction Manager, Contractor, RPR, Owner, and others as required.

C. The agenda of these project meetings will include reports on construction progress, the status of submittal reviews, the status of information requests, and any general business. The weekly construction meetings will be conducted by the Contractor. The Contractor shall keep minutes of the proceedings. The minutes shall be typed and distributed to all attendees within 48 hours of each meeting. The monthly construction meetings will be conducted by the Owner's Engineer's Construction Manager or RPR. The Owner's Engineer shall keep minutes of the proceedings. The minutes shall be typed and distributed to all attendees within 48 hours of each meeting.

END OF SECTION

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SECTION 01 32 16

CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.01 PURPOSE

A. The OWNER is committed to delivering quality, cost-effective infrastructure to its customers in a timely manner. One of the most important tools the OWNER uses to achieve this goal is accurate, updated, current schedules for its capital projects. Accurate and updated schedules allow the OWNER to effectively track and manage its projects.

B. The OWNER's goal is to take every reasonable step to ensure that projects finish on time and within budget. Project schedules are the fundamental building blocks to planning and executing projects efficiently and on time. These schedules are best prepared by those closest to the work. Because the vast majority of capital project delivery at the OWNER is performed by CONTRACTOR, it is critical that CONTRACTOR prepare schedules as part of performing their work for the OWNER.

C. This Schedule Guidance Document is designed to guide CONTRACTOR in preparing and submitting acceptable schedules for use by the OWNER and ENGINEER.

1.02 APPLICABILITY AND BASIC REQUIREMENTS

A. CONTRACTOR is responsible for preparing schedules as defined herein and as required in their contracts. A waiver allowing a CONTRACTOR not to prepare a schedule in accordance with this Schedule Guidance Document may only be granted by the OWNER or ENGINEER.

B. There are three (3) basic elements to schedule submittals.
   1. Baseline Schedule: Initial schedule submitted before work begins that will serve as the baseline for measuring progress and departures from the schedule. The Baseline Schedule is prepared by the CONTRACTOR at the beginning of the project and submitted to the OWNER and ENGINEER for review and approval.
   2. Progress Schedule: Monthly submittal of a Progress Schedule documenting progress on the project and any changes anticipated. The Progress Schedule is prepared monthly by the CONTRACTOR and submitted to the OWNER and ENGINEER.
   3. Schedule Narrative: Concise narrative that highlights changes in the schedule, expected delays, key schedule issues, etc., along with a cash flow graph or summary table. The Schedule Narrative is submitted to the OWNER and ENGINEER monthly in conjunction with the Progress Schedule.

C. The schedules required herein will be prepared using the following software (or saved down in the following version) in order to be compatible with the OWNER's Engineer's schedule system, unless prior permission to use another software is requested and granted by the OWNER.
   1. Primavera Project Planner (now owned by Oracle) version 8.2 or later
   2. or Microsoft Project.

D. Completion time and all specific dates given in the Contract Documents, and sequencing requirements described in Section 01 12 16, shall be shown on the schedule. Activities making up the critical path shall be identified.

1.03 BASELINE SCHEDULE

A. General: The CONTRACTOR will develop a cost loaded schedule using the software version required in Section 1.2 and the Critical Path Method (CPM).
   1. The OWNER will inform the CONTRACTOR of the Project Code (Project Number) for the Project. The file naming convention is demonstrated in the examples below.
      a. Baseline
         Format. ProjectCode (project number)_DocumentType_Date_
         Example. 1701_ScheduleBaseline_03162024.XER
      b. Monthly Update
         Format. ProjectCode (project number)_DocumentType_Date_
         Example. 1701_ScheduleUpdate_03162024.XER
      c. Monthly Schedule Narrative
         Format. ProjectCode (project number)_DocumentType_Date_
         Example. 1701_ScheduleNarrative_03162024.DOC
   2. The approved Baseline Schedule is a part of the contract by reference. The CONTRACTOR has the sole responsibility to correct any latent defects in the Baseline Schedule and perform to the subsequently revised schedule.
   3. The CONTRACTOR will use the Baseline Schedule to coordinate and monitor the work (including the activities of subcontractors, equipment vendors and suppliers).
   4. The CONTRACTOR must keep a copy of the approved Baseline Schedule.

B. Schedule Work Breakdown Structure and Activities
   1. **Work Breakdown Structure (WBS):** The Work Breakdown Structure is designed to meet the basic reporting needs for the OWNER's financial and tracking systems. The CONTRACTOR's project-specific WBS should work within this basic framework and provide additional detail to efficiently deliver and track the work.
      a. WBS elements that are definitely not a part of the scope of services need not be included in the schedule. Note that as many subtasks and activities as desired may be included underneath the WBS elements.
   2. **Activities**: Activities are the discrete elements of work that make up the schedule. They should be organized underneath the umbrella of the WBS as described in Exhibit A.
      a. The following information should be provided for each activity:
         1) Activity ID Number
            a) Use a four-digit number left justified in the activity I.D. field.
            b) Alphanumeric activity numbers are NOT acceptable.
      b. Activity Description
         1) Activity descriptions should adequately describe the activity and in some cases the extent of the activity. Examples of acceptable descriptions might include "install pipeline between Point A and Point B", "water line route layout", etc.).

c. Activity Durations
    1) The activity duration will be based upon the physical amount of work that is to be performed for the stated activity and are limited to 20 working days. If work is to exceed 20 days, then break the work down so the work will be completed within a 20-day time frame.
    2) The intent of this requirement is to ensure that the activities are segmented sufficiently to adequately track progress.
d. Activity Start and Finish Dates
    1) Activity start and finish dates will only be accepted if calculated by the software.
    2) Actual activity start and finish dates may not be assigned in a baseline. However, they must accurately be assigned in the working version of the schedule (see Section 4 Progress Schedule).
e. Activity Dependencies
    1) All activities will be logically tied with a predecessor and a successor. The only exception to this rule will be for the project start and project finish milestones.
f. Milestone Activities
    1) The following milestone activities (i.e., important events on a project that mark critical points in time) are of particular interest to the OWNER and ENGINEER and should be reflected in the Project Schedule for all phases of work, as applicable. Notice to Proceed (Construction)
    2) Draft Baseline Schedule submittal
    3) Preparation and submission of shop drawings, submittals, and any required re-submittals (if applicable)
    4) Mobilization
    5) Fabrication and delivery of equipment and materials (if applicable)
    6) Substantial Completion
    7) Construction Complete

C. **Baseline Schedule Development: The** CONTRACTOR will designate an authorized representative (Project Scheduler) responsible for developing and updating the schedule and preparing reports. It is recommended that a qualified scheduler develop the Baseline Schedule.
1. The CONTRACTOR's initial schedule submittal will contain NO progress and represent the planned work for the duration of the project. Once approved by the OWNER and ENGINEER, this schedule will become the baseline against which all future variance analysis will be performed.
2. The use of activity external constraint dates and lags on relationships is discouraged unless specified or approved by the OWNER and ENGINEER. An example of an external constraint date is "concrete placement will begin no later than January 1." The reason for this requirement is that it creates an artificial (rather than calculated) critical path.
3. The Baseline Schedule will consider delivery lead times, construction and access constraints and the coordination of construction with OWNER operations.
    a. **Safety Requirements:** Schedule performance should never take precedence over safety. Project schedules must allow work to be performed in a safe manner.

1) The CONTRACTOR cannot reduce safety or worker protection in order to shorten schedules, recover lost time or accelerate the work.

b. **Inclement Weather**: Refer to climatology data for anticipating work that can be affected by inclement weather. Historical rain days can be reviewed from the following web site: http://www.noaa.gov/climate

D. Changes to Approved Baseline Schedule: The approved Baseline Schedule is the basis for measuring progress on the project (see Paragraph 1.4, Progress Schedule). As such, the CONTRACTOR should develop the Baseline Schedule considering the realistic delivery of the work tasks and likely constraints.

1. Total and free float is not for the exclusive use or benefit of either the OWNER or the CONTRACTOR, but is a resource available to both parties for the benefit of the project on a first needed basis. Changes to the Baseline Schedule will only be considered after all float has been consumed.
2. Changes to the approved Baseline Schedule may only be considered under limited circumstances. If warranted, any changes will require PRIOR approval by the ENGINEER's Designee and OWNER's Program Manager. Project circumstances that could be considered by the OWNER as potentially warranting re-baselining include the following:
   a. Change Orders to the contract affecting the scope of the work to be performed and the associated schedule completion date

1.04 PROGRESS SCHEDULE

A. As described in Paragraph 1.3, the Baseline Schedule is used to coordinate and monitor the work. The CONTRACTOR is required to keep a copy of the approved Baseline Schedule.

B. The Progress Schedule is simply a copy of the approved Baseline Schedule that will be statused monthly. In other words, progress on the project will be shown monthly as an update of the schedule that will be compared to the approved Baseline Schedule.

C. Note that the Progress Schedule will be statused (data date) through month end, although the submittal date must comply with Paragraph 1.06 of this section.

1. **Progress Updates:** The CONTRACTOR should show on the Progress Schedule updates of the following:
   a. The actual dates that activities start
   b. The actual dates that activities finish
   c. The remaining duration of activities in progress
   d. The percent complete of all activities on the schedule (0 percent to 100 percent complete)
2. **Schedule Narrative**: The Progress Schedule will be accompanied monthly by a concise Schedule Narrative that explains the submitted schedule. The purpose of the Schedule Narrative is to:
   a. Speed review time
   b. Explain variances from Baseline on critical path activities
   c. Explain to the OWNER and ENGINEER logic changes and potential schedule conflicts related to dependences.
   d. Concisely summarize the projected cash flow for the project based on the statused schedule.

3. If the project is on schedule, and no significant issues related to schedule exist, then the Schedule Narrative is extremely brief. On the other hand, if the project is falling behind, and/or there are significant conflicts and obstacles to meeting the Baseline Schedule, then the Schedule Narrative should describe the issues and what steps will be necessary for the project to recover. Sharing this information ensures that the entire project team will be aware of the issues and have opportunity to assist, where applicable.

1.05 ADDITIONAL GUIDANCE APPLICABLE TO CONSTRUCTION SCHEDULES ONLY

A. In addition to the requirements in Sections 1.1 – 1.4 of this Schedule Guidance Document, the CONTRACTOR's schedule will include the following.
   1. Schedule of Value Pay Items: Schedule of Values Pay Items (Work) shall be loaded into the scheduling software using the labor, materials, and equipment resource types showing the quantity of Work to be done along with the corresponding value of the Work measured in dollars.

1.06 SUBMITTAL OF SCHEDULES

A. Submittal File Formats: Every time that a schedule or report is submitted (baseline and monthly progress) the following file formats are required.
   1. Baseline Schedule: Submit the schedule in native file format (see below).
      a. Also submit a .pdf of the bar chart schedule consisting of the following columns:
         1) Activity ID
         2) Activity Name
         3) Duration
         4) Start Date
         5) Finish Date
         6) Float
         7) Cost
   2. Progress Schedule: Submit the schedule in native file format (see below).
      a. Also submit a .pdf of the bar chart schedule consisting of the following columns:
         1) Activity ID
         2) Activity Name
         3) Physical Percent Complete
         4) Duration
         5) Start Date
         6) Finish Date
         7) Total Float
         8) Remaining Total Cost
   3. Schedule Narrative: Submit the schedule narrative in .doc format.
   4. Native Schedule File Formats: The native file structure is to save the schedule as follows:
      a. In Primavera 6, save the file as an .XER file.
      b. In Microsoft Project, save the file as an .MPP file.

B. **Submittal Process**: All submittals of schedules must be made to the ENGINEER's Construction Manager. Draft project Baseline Schedules must be submitted within thirty (30) calendar days after the formal Notice to Proceed from the OWNER. All schedules must be submitted in their native format (.XER file or .MPP) as well as in a PDF format. The ENGINEER's Construction Manager will review, accept or reject the schedule within five (5) days of submittal.

1. Once the Baseline Schedule has been accepted, Progress Schedule updates will be due monthly prior to the monthly progress meetings.

END OF SECTION

SECTION 01 32 23

SURVEY AND LAYOUT DATA

PART 1 GENERAL

1.01 SURVEY AND LAYOUT

A. The Owner will establish reference benchmarks and baselines as specified.

B. Contractor shall preserve all benchmarks, control points and stakes. Contractor shall Replace benchmarks, control points and stakes destroyed or disturbed at Contractor's cost.

C. Use a licensed land surveyor to replace all property corners or other monuments marked or shown on the plans that are destroyed by the work.

D. From the information provided, the Contractor shall develop and make such additional surveys as are needed for construction, such as control lines, slope stakes, batter boards, stakes for pipe locations and other working points, lines, and elevations.

E. Survey work shall be performed under the supervision of a licensed land surveyor or registered civil engineer. Contractor shall reestablish reference benchmarks and survey control monuments destroyed by his operations at no cost to the Owner.

END OF SECTION

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SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes administrative and procedural requirements for submittals.

1.02 ADMINISTRATIVE REQUIREMENTS

A. General:
   1. Furnish submittal items as specified in the Contract Documents.
   2. Review submittal information to verify it is accurate and fulfills specified submittal requirements before submitting for review and comment.
   3. Edit submittal content to clearly indicate only those items, models, or series of equipment, which are being submitted for review. Cross out or otherwise obliterate extraneous materials.
   4. Ensure there is no conflict with other submittals and notify the Owner's Representative in each case where the submittal may affect the work of another contractor or the Owner.
   5. Coordinate submittals among subcontractors and suppliers including those submittals complying with unit responsibility requirements specified in the Contract Documents.
   6. For each submittal, certify field conditions, compliance with the Contract Documents, and review of the submittal prior to submitting for review.
   7. Designate the installation location within the facility, application, or intended purpose for each submittal item. Review comments are solely applicable to the circumstances designated in the submittal.
   8. Coordinate submittals with the work so that work will not be delayed. Coordinate and schedule different categories of submittals, so that one will not be delayed for lack of coordination with others.
   9. No extension of time will be allowed because of failure to properly schedule, coordinate or compile submittals.
   10. Submittals will be rejected for lack of legibility, lack of coordination, ambiguity, or are incomplete. Incomplete submittals will be returned without review.
   11. Do not proceed with work related to a submittal until the submittal process is complete. This requires that submittals for review and comment be returned to the Contractor stamped "No Exceptions Taken" or "Make Corrections Noted."
   12. If desired, authorize material or equipment suppliers to deal directly with the Owner's Representative regarding a submittal. Such dealings require written authorization from the Contractor and are limited to contract interpretations to clarify and expedite the work.

1.03 DEFINITITIONS

A. Action Submittals:
   1. Action Submittals content require review and response by the Owner's Representative before proceeding with incorporating the subject equipment, materials, or procedure into the work.
   2. Review comments on Action Submittals, and perform subsequent actions based on the REVIEW ACTION requirements specified below.

B. Informational Submittals:
   1. Informational Submittals are examined to verify that the specified submittal contents have been furnished as specified.
   2. The Contractor's actions are not contingent on the disposition of review comments on Informational Submittals.
   3. Review comments on Informational Submittals, and perform subsequent actions based on the REVIEW ACTION requirements specified below.

C. Closeout Submittals:
   1. Closeout Submittals consist of documentation that is not available for review at the time Action Submittals are submitted for review or documentation that is typically generated or furnished following incorporation of the equipment, materials, or procedure into the work. Closeout submittals include spare parts inventory listing, spare parts, extra stock materials, special tools and other materials or components that are furnished separate from the installed and completed work.
   2. Review comments on Closeout Submittals, and perform the subsequent actions based on the REVIEW ACTION requirements specified below.

D. Samples:
   1. Samples include partial sections of components, cuts, or containers of materials, color range sets, and swatches showing color, texture and pattern.
   2. Samples may be Action or Informational submittals.

E. Mock-Ups:
   1. Mock-ups are scale representations of items to be constructed as part of the work as required in the Contract Documents.
   2. Mock-ups are Action Submittals.

F. Review Actions:
   1. The following definitions and actions are associated with the REVIEW ACTIONS DEFINED below:
      a. NO EXEPTIONS TAKEN: If the review indicates that the material, equipment or work method complies with the Contract Documents, submittal will be marked "NO EXCEPTIONS TAKEN." Implement the work method or incorporate the material or equipment covered by the submittal.

b. MAKE CORRECTIONS NOTED: If the review indicates limited corrections are required, submittals will be marked "MAKE CORRECTIONS NOTED." Implement the work method or incorporate the material and equipment covered by the submittal in accordance with the noted corrections. Where submittal information will be incorporated in O&M data, provide a corrected copy.

c. AMEND AND RESUBMIT: If the review reveals that the submittal is insufficient or contains incorrect data, submittals will be marked "AMEND AND RESUBMIT." Do not undertake work until the submittal has been revised, resubmitted and returned marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED".

d. REJECTED – SEE REMARKS: If the review indicates that the material, equipment, or work method does not comply with Contract Documents, the submittal will be marked "REJECTED - SEE REMARKS." Do not undertake the work covered by such submittals until a new submittal is made and returned marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED" except at your own risk.

1.04 MASTER SUBMITTAL LIST

A. A minimum of five (5) business days following the Notice to Proceed, the Contractor will provide the Owner's Representative a Master Submittal List listing anticipated submittal requirements for the contract.

B. Contractor shall update the list as submittals are completed and transmit to the Owner's Representative. Provide updated list to Owner's Representative monthly.

C. Include the following as a minimum in the updated list:
   1. Submittal number.
   2. Date submitted.
   3. Requested time for return of comments.
   4. Special requests, if any, for that particular submittal.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 SUBMITTAL PROCEDURES

A. General:
   1. Owner's Representative will review submittal information and indicate a REVIEW ACTION. Review of submittals does not relieve the Contractor of responsibility for performance of the work according to the Contract Documents.
   2. Coordinate submittal transmittal for related elements of work to ensure the submittals are processed as needed to meet the intent of the work and that delays are minimized.
   3. Submittal review activity will be prioritized based on the order received unless otherwise requested by the Contractor.
   4. Submittal sequencing should coincide with the Construction Schedule in Section 01 32 16 - Construction Progress Schedule.

5. A review duration of 15 calendar days is allotted for each submittal, from the date of receipt by the Owner's Representative to the date of return to the Contractor.
    a. Additional time is allotted for the following submittals:

Section	Title	Review Duration
33 16 13.13	Steel Aboveground Water Utility Storage Tanks	30 days
Div 40	All Division 40 Specifications	20 days
Div 43	Division 43 Specifications (typical)	20 days
43 31 13.13	Vertical GAC Liquid Adsorption Contactors	30 days
Div 46	Division 46 Specifications (typical)	20 days
46 31 11	Chlorine Gas Feed Equipment	30 days
46 61 16	Granular Activated Carbon Media	30 days
46 61 33	Membrane Filtration Systems	30 days

B. Submittal Preparation:
    1. Excepting, mock-ups, spare parts, physical samples, and other items that cannot be converted to electronic media, furnish submittal contents electronically in a searchable PDF format.
        a. Include a table of contents and labeled divider sheets that are coordinated with the table of contents.
        b. Diagrams, drawings, pictures, and illustrations presented with a consistent orientation.
    2. Shop Drawings, Samples and Mock-ups
        a. Submit one electronic copy per the requirements described above and the following:
            1) Shop Drawings: one (1) reproducible and three (3) prints for job site reference. One marked up print will be returned to the Contractor when the review is complete.
            2) Samples: three (3) samples
            3) Mock-up: As required by individual specification
            4) Demonstrations: As required to facilitate installation and inspection
        b. Reference applicable specifications for additional requirements

C. Submittal Completeness:
    1. Submittals without all required information are not acceptable and may be marked "REJECTED" and returned without review.
    2. For a submittal to be deemed complete, provide the information required below and specified in specification sections, including those elements in the special transmittal procedures where required.

D. In the event of the need to "revise and resubmit", provide a complete stand-alone submittal with corrections, revisions, and new information clearly identified.

E. Resubmit changes to submittals that require a stamp and signature by a licensed engineer or other certification with the requisite stamp and signature or certifications.

3.02 TRANSMITTAL PROCEDURE

A. General:
   1. Include the following information on the submittal transmittal form:
      a. Project names and date, including Owner's Project Number as follows: 4028.21254.01
      b. Name of Contractor and Subcontractor
      c. Name of supplier and name of manufacturer
      d. Number and title of appropriate specification section
      e. Drawing number and detail references, as appropriate
   2. Equipment and Material Submittals: Unless otherwise specified, complete the Transmittal Form 01 33 00-A - Submittal Transmittal Form specified in Section 01 99 90 - Reference Forms.
   3. Operation and maintenance manuals, information and data Submittals: Complete the Transmittal Form 01 78 23-A - Operation and Maintenance Transmittal Form specified in Section 01 99 90 - Reference Forms.
   4. Use a separate form for each specific item, class of material, equipment, and items specified in separate, discrete sections, for which a submittal is required. Identify the appropriate equipment numbers for submittal documents common to more than one piece of equipment. Submit a single form for multiple items, if the items taken together constitute a Supplier's package or are functionally related, to facilitate checking or reviewing the group or package as a whole.
   5. Assign a unique sequential number to each transmittal form accompanying each item submitted.
      a. Format submittal numbers as follows: "SS SS SS-XXX"; where "SS SS SS" is the referenced 6-digit section number from the Specifications and "XXX" is the sequential number assigned by the Contractor.
      b. Format resubmittals as follows: "SS SS SS-XXX-YY"; where "XXX" is the originally assigned submittal number and "YY" is a sequential number assigned for resubmittals, i.e., 00, 01, or 02 being the original, 1st, and 2nd resubmittals, respectively. Submittal 43 23 50-001-02, for example, is the second resubmittal of submittal 001 pertaining to Section 43 23 50.
   6. Deviation from contract: If deviations from the material, equipment or method of work are proposed, describe the proposed deviation and explain the reason for proposing the deviation under "deviations" on the transmittal form accompanying the submittal copies.

B. Document Management System Specific Procedures:
   1. Unless otherwise specified, submittals regarding material and equipment shall be submitted electronically using a document control program/website.
   2. Login information and instructions will be provided to Contractor upon project award.

C. Check Marked Specification Transmittal Procedures:
   1. When submittal requirements require a “marked” copy of the specification, provide a copy of the specification marked as indicated below. Provide the following when transmitting the submittal:
      a. Provide a copy of the specification section(s) that specifies a marked copy of the specification. Include addendum updates and referenced specification sections, with addendum updates. Complete the following:
         1) Checkmark each paragraph to indicate submittal compliance with that specification requirement. Check marks (✓) shall denote full compliance with that paragraph as a whole.
         2) Mark paragraphs where deviations are proposed by underlining text that is the subject of the proposed deviation. Denoting each proposed deviation with a number in the margin to the right of the identified paragraph and provide a detailed written explanation for each numbered deviation. The remaining portions of the paragraph not underlined signify compliance with specified requirements.
         3) The Engineer is the final authority for determining acceptability of requested deviations.
      b. For equipment specifications, provide a copy of the control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the subject equipment. Complete the following:
         1) Mark drawings or diagrams to show specific changes necessary for the equipment proposed in the submittal.
         2) If no changes are required, mark the drawings or diagrams with "no changes required".

D. Provide a Certificate of Unit Responsibility assigning unit responsibility in accordance with the requirements of the specification Section. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with the Specifications.

E. Samples and Mock-ups:
   1. Submit samples and mock-ups in accordance with the Contract Documents. Package samples to facilitate review. Include the following with the Submittal Transmittal Form:
      a. Generic description of the sample
      b. Sample source
      c. Product name and name of manufacturer
      d. Compliance with recognized standards
      e. Submittal Number
      f. Availability and delivery time
      g. Specification Section
   2. Submit samples and mock-ups before installation. Where variation in color, pattern, texture or other characteristics are inherent in the material, submit four units to show variation range.
   3. Where samples are for selection of appearance characteristics from a range of standard choices, submit a full set of choices for the material or products.

4. Maintain sets of approved samples and mock-ups at the Project Site, for quality comparisons throughout the course of construction.
5. Demolish and remove all samples and mock-ups prior to substantial completion.

3.03 REVIEW PROCEDURE

A. General:
   1. Owner's Representative will review each submittal, indicate a REVIEW ACTION, and return to the Contractor.
   2. Returned submittals indicate one of the following REVIEW ACTIONS: NO EXEMPTIONS TAKEN, MAKE CORRECTIONS NOTED, AMEND AND RESUBMIT, or REJECTED – SEE REMARKS.

3.04 EFFECT OF REVIEW OF CONTRACTOR'S SUBMITTALS

A. General:
   1. Review of contract drawings, methods of work, or information regarding materials or equipment the Contractor proposes to provide, does not relieve the Contractor of responsibility for errors therein and is not regarded as an assumption of risks or liability by the Owner's Representative or the Owner, or by any officer or employee thereof, and the Contractor has no claim under the contract on account of the failure, or partial failure, of the method of work, material, or equipment reviewed. A mark of "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED" means that the Owner has no objection to the Contractor, upon his own responsibility, using the plan or method of work proposed, or providing the materials or equipment proposed.

END OF SECTION

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SECTION 01 35 43

ENVIRONMENTAL PROCEDURES

PART 1 GENERAL

1.01 SITE MAINTENANCE

A. The Contractor shall keep the work site clean and free from rubbish and debris. Materials and equipment shall be removed from the site when they are no longer necessary. Upon completion of the work and before final acceptance, the work site shall be cleared of equipment, unused materials, and rubbish to present a clean and neat appearance.

1.02 TEMPORARY DAMS

A. Except in time of emergency, earth dams are not acceptable at catch basin openings, local depressions, or elsewhere. Temporary dams of sand bags, asphaltic concrete, or other acceptable material will be permitted when necessary to protect the work, provided their use does not create a hazard or nuisance to the public. Such dams shall be removed from the site as soon as they are no longer necessary.

1.03 AIR POLLUTION CONTROL

A. The Contractor shall not discharge smoke, dust, and other contaminants into the atmosphere that violate the regulations of any legally constituted authority. He shall also abate dust nuisance by cleaning, sweeping, and sprinkling with water, or other means as necessary. The use of water, in amounts which result in mud on public streets, is not acceptable as a substitute for sweeping or other methods.

1.04 NOISE CONTROL

A. Between 7:30 p.m. and 7:00 a.m., noise from Contractor's operations shall not exceed limits established by applicable laws or regulations and in no event shall exceed 86 dBA at a distance of 50 feet from the noise source.

END OF SECTION

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SECTION 01 41 26

PERMITS

PART 1 GENERAL

1.01 SCOPE

A. The CONTRACTOR shall secure and pay for permits required for the execution of work in accordance with the Contract Documents. Record copies of these permits shall be provided to the OWNER.

B. The intent of this Section is to furnish the CONTRACTOR with additional known information for permits required for the project.

C. The CONTRACTOR shall include in their Bid Price(s) the cost of obtaining all necessary permits, including application fees, inspections, testing and other costs, and the costs of complying with the conditions of all permits, whether listed here or not. Any fees listed in this section are estimates and for the CONTRACTOR's information only. The CONTRACTOR shall verify and pay all actual fees.

D. Completeness of the list is not guaranteed by the OWNER, RPR, CONSTRUCTION MANAGER or ENGINEER. The absence of information does not relieve the CONTRACTOR of responsibility for determining and verifying the extent of permits required and of obtaining permits.

E. The CONTRACTOR shall submit, within 10 days of the Notice to Proceed, a list of all permits and licenses that the CONTRACTOR intends to obtain, indicating the agency required to grant the permit, the expected date of submittal for the permit, and required date for receipt of the permit.

F. During project closeout, the CONTRACTOR shall hold a meeting with the RPR and CONSTRUCTION MANAGER to:
   1. Review all stipulations for CONTRACTOR and OWNER obtained permits.
   2. Verify proper closeout of all permits with the corresponding permitting agencies.

1.02 SUMMARY OF PERMITTING AGENCIES

A. Permits, as required, shall be obtained by the CONTRACTOR from the following agencies. Copies of these permits shall be submitted to the ENGINEER and be held on-site. The CONTRACTOR shall comply with all conditions of the permits.
   1. Arizona Department of Transportation (ADOT)
   2. Bureau of Indian Affairs (highway crossings)
   3. Western Area Power Administration (WAPA) (230kV powerline crossing)
   4. Los Angeles Department of Water and Power (LADWP) (500 kV powerline crossing)

1.03 ADOT ENROACHMENT PERMIT AND PERMIT EXCAVATION

A. ENCROACHMENT PERMIT:
   1. One encroachment permit shall be required per ADOT ROW (highway) in which Work is performed by the CONTRACTOR including but not limited to:
      a. Highway 98.
   2. Contingency Plan
      a. The Encroachment Permit shall include a Contingency Plan that includes provisions for 1, 2, and 3 lane closures from possible construction failures.
   3. ADOT Permit information is available at: Contacts - Northcentral District | Department of Transportation (azdot.gov)

B. ADDITIONAL ADOT REQUIREMENTS:
   1. Reference ADOT's 2021 Standard Specifications and Construction Standard Drawings – May 2012 for all work within ADOT's ROW (Access online at 2021_Standard_Specifications_for_Road_and_Bridge_Construction_PC.pdf (azdot.gov) and Construction Standard Drawings | Department of Transportation (azdot.gov)).
   2. Reference Special Provision Sections and Drawings for ADOT utility depths.

1.04 EXISTING UTILITY ENROACHMENT PERMITS

A. CONTRACTOR shall obtain any petroleum products, natural gas, telecommunication, electric or other utility encroachment permits.

1.05 GENERAL PERMIT FOR CONSTRUCTION DEWATERING AND HYDROSTATIC TESTING

A. The CONTRACTOR shall acquire permits required by the Navajo Nation Environmental Protection Agency (NNEPA) to perform the Work. The CONTRACTOR is responsible for obtaining permits, paying all related fees, and complying with all conditions of the permit including analysis, treatment, and conveyance of discharge water, as necessary.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 42 19

REFERENCE STANDARDS

PART 1 GENERAL

1.01 ABBREVIATOINS

A. Wherever used in the project manual, the following abbreviations will have the meanings listed:

Abbreviation	Meaning
AA	Aluminum Association Incorporated P.O. Box 753 Waldorf, MD 20604
AABC	Associated Air Balance Council 1518 K Street N.W. Washington, DC 20005
AAMA	American Architectural Manufacturers Association 1540 East Dundee Road, Suite 310 Palatine, IL 60067
AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol Street, N.W., Suite 249 Washington, DC 20001
ABMA	American Bearing Manufacturers Association 1200 19th Street N.W., Suite 300 Washington, DC 20036
ACI	American Concrete Institute 22400 West Seven Mile Road P.O. Box 19150, Redford Station Detroit, MI 48219
AEIC	Association of Edison Illuminating Companies 600 North 18th Street P.O. Box 2641 Birmingham, AL 35291
AGA	American Gas Association ATTN: Records 1515 Wilson Boulevard Arlington, VA 22209
AGMA	American Gear Manufacturer's Association, Inc. 1500 King Street, Suite 201 Alexandria, VA 22314
AHA	American Hardboard Association 1210 West Northwest Highway Palatine, IL 60067
AISC	American Institute of Steel Construction One East Wacker Drive, Suite 3100 Chicago, IL 60601

Abbreviation	Meaning
AISI	American Iron and Steel Institute 1101 Seventeenth Street, NW, Suite 1300 Washington, DC 20036
AITC	American Institute of Timber Construction 7012 South Revere Parkway, Suite 140 Englewood, CO 80112
ALSC	American Lumber Standard Committee P.O. Box 210 Germantown, MD 20875
AMCA	Air Movement and Control Association, Inc. 30 West University Drive Arlington Heights, IL 60004
ANSI	American National Standards Institute 11 West 42nd Street, 13th Floor New York, NY 10036
APA	American Plywood Association 7011 South 19th Street Tacoma, WA 98466
API	American Petroleum Institute 1220 "L" Street N.W. Washington, DC 20005
ARI	Air-Conditioning and Refrigeration Institute 4301 North Fairfax Drive, Suite 425 Arlington, VA 22203
ASCE	American Society of Civil Engineers United Engineering Center 345 East 47th Street New York, NY 10017
ASCII	American Standard Code for Information Interchange United States of America Standards Institute 10 East 40th Street New York, NY 10016
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc. 1791 Tullie Circle, NE Atlanta, GA 30329
ASME	American Society of Mechanical Engineers 345 East 47th Street New York, NY 10017
ASTM	American Society for Testing and Materials 100 Barr Harbor Drive West Conshohocken, PA 19428
AWPA	American Wood-Preservers' Association 9549 Old Fredrick Road Ellicott City, MD 21042

Abbreviation	Meaning
	or P.O. Box 286 Woodstock, MD 21163-0286
AWS	American Welding Society 550 NW LeJeune Road P.O. Box 351040 Miami, FL 33135
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
BOCA	Building Officials and Code Administrators, International, Inc. 4051 West Flossmoor Road Country Club Hills, IL 60478
CBM	Certified Ballast Manufacturers 2120 Keith Building Cleveland, OH 44115
CMAA	Crane Manufacturers Association of America, Inc. (Formerly called: Overhead Electrical Crane Institute) (OECI) 8720 Red Oak Boulevard, Suite 201 Charlotte, NC 28217
CRSI	Concrete Reinforcing Steel Institute 933 N Plum Grove Road Schaumburg, IL 60173
DEMA	Diesel Engine Manufacturer's Association 30200 Detroit Road Cleveland, OH 44145
DHI	Door and Hardware Institute 14170 Newbrook Drive Chantilly, VA 22021
EEI	Edison Electric Institute 90 Park Avenue New York, NY 10016
EIA	Electronic Industries Association Order from: Global Engineering Documents 18201 McDurmott West Irvine, CA 92714
EJMA	Expansion Joint Manufacturers Association 25 North Broadway Tarrytown, NY 10591
FM	Factory Mutual Engineering and Research Corporation 1151 Boston-Providence Turnpike P.O. Box 9102 Norwood, MA 02062

Abbreviation	Meaning
HEI	Heat Exchange Institute 1300 Sumner Avenue Cleveland, OH 44115
HI	Hydraulic Institute 9 Sylvan Way, Suite 180 Parsippany, NJ 07054
HPVA	Hardwood Plywood & Veneer Association 1825 Michael Faraday Drive P.O. Box 2789 Reston, VA 22090-2789
IAPMO	International Association of Plumbing and Mechanical Officials 20001 Walnut Drive S Walnut, CA 91789
IBC	International Building Code 200 Massachusetts Avenue Washington, DC
ICBO	International Conference of Building Officials 5360 Workman Mill Road Whittier, CA 90601
ICEA	Insulated Cable Engineers Association P.O. Box 440 South Yarmouth, MA 02664
IEEE	Institute of Electrical and Electronics Engineers 445 Hoes Lane P.O. Box 1331 Piscataway, NJ 08855
IES	Illuminating Engineering Society of North America 120 Wall Street New York, NY 10017
ISA	International Society of Automation 67 Alexander Drive P.O. Box 12277 Research Triangle Park, NC 27709
JIC	Joint Industrial Council 7901 West Park Drive McLean, VA 22101
MFMA	Metal Framing Manufacturers Association 401 N. Michigan Avenue Chicago, IL 60611
MSS	Manufacturers Standardization Society of the Valve & Fittings Industry, Inc. 127 Park Street, N.E. Vienna, VA 22180
NAAMM	National Association of Architectural Metal Manufacturers 11 South La Salle Street, Suite 1400 Chicago, IL 60603

Abbreviation	Meaning
NACE	National Association of Corrosion Engineers 1440 South Creek Drive Houston, TX 77084
NBC	National Building Code Published by BOCA
NEC	National Electric Code National Fire Protection Association One Batterymarch Park P.O. Box 9101 Quincy, MA 02169
NEMA	National Electrical Manufacturer's Association 2101 L Street, NW, Suite 300 Washington, DC 20037
NESC	National Electric Safety Code American National Standards Institute 1430 Broadway New York, NY 10018
NFOR	National Forest Products Association (Formerly National Lumber Manufacturer's Association) 1111 19 Street NW, Suite 700 Washington, DC 20036
NFPA	National Fire Protection Association One Batterymarch Park P.O. Box 9101 Quincy, MA 02169
NHLA	National Hardwood Lumber Association 6830 Raleigh LaGrange P.O. Box 34518 Memphis, TN 38184-0518
NSF	National Sanitation Foundation 3475 Plymouth Road P.O. Box 130140 Ann Arbor, MI 48113
OSHA	Occupational Safety and Health Act U.S. Department of Labor Occupational and Health Administration San Francisco Regional Office 450 Golden Gate Avenue, Box 36017 San Francisco, CA 94102
PCI	Precast/Prestressed Concrete Institute 175 West Jackson Blvd., Suite 1859 Chicago, IL 60604
PPIC	The Plumbing & Piping Industry Council, Inc. 510 Shatto Place, Suite 402 Los Angeles, CA 90020

Abbreviation	Meaning
RMA	Rubber Manufacturers Association 1400 K Street NW, Suite 900 Washington, DC 20005
SAE	Society of Automotive Engineers, Inc. 400 Commonwealth Drive Warrendale, PA 15096
SAMA	Scientific Apparatus Makers Association One Thomas Circle Washington, DC 20005
SBC	Standard Building Code Published by SBCCI
SDI	Steel Door Institute 30200 Detroit Road Cleveland, OH 44145
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc. P.O. Box 221230 Chantilly, VA 22021
SPI	Society of the Plastics Industry, Inc. 1275 K Street NW, Suite 400 Washington, DC 20005
SPIB	Southern Pine Inspection Bureau 4709 Scenic Highway Pensacola, FL 32504
SSPC	Society for Protective Coatings 40 24th Street, 6th Floor Pittsburgh, PA 15222
SSPWC	Standard Specifications for Public Works Construction Building News, Inc. 3055 Overland Avenue Los Angeles, CA 90034
TEMA	Tubular Exchanger Manufacturer's Association 25 North Broadway Tarrytown, NY 10591
TPI	Truss Plate Institute 583 D'Onofrio Drive, Suite 200 Madison, WI 53719
UBC	Uniform Building Code Published by ICBO
UL	Underwriters Laboratories Inc. 333 Pfingsten Road Northbrook, IL 60062
UMC	Uniform Mechanical Code Published by ICBO
UPC	Uniform Plumbing Code Published by IAPMO

Abbreviation	Meaning
USBR	Bureau of Reclamation U.S. Department of Interior Engineering and Research Center Denver Federal Center, Building 67 Denver, CO 80225
WWPA	Western Wood Products Association (Formerly called: West Coast Lumbermen's Association (WCLA)) Yeon Building 522 SW 5th Avenue Portland, OR 97204

END OF SECTION

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SECTION 01 45 00

CONTRACTOR QUALITY CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies administrative and procedural requirements for quality control services, field inspections and field testing of civil and structural constructs required for this project.

B. The Contractor is responsible for the quality assurance and quality control of their respective work for the construction of this project in accordance with the Contract Documents.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related section. Additional related sections may apply that are not specifically listed below.

1. Section 01 45 23 Testing and Inspection Services

1.03 DEFINITIONS

A. Quality Control System (QCS): The quality control, assurance, and inspection system established and carried out to ensure compliance with the Plans and specifications.

B. QCS Supervisor: That person in responsible charge of the work occurring, as designated by the Contractor in the QCS Plan.

C. QCS Inspector: Responsible, certified personnel inspecting the various constructs at specified milestones and during the project overall and designated by the Construction Manager.

D. Factory Test: Tests made on various materials, products and component parts prior to shipment to the job site.

E. Field Tests: Tests and analyses made at or in the vicinity of the job site in connection with the actual construction.

F. Certified Inspection Report: Reports signed by approved inspectors attesting that the items inspected meet the specification requirements other than any exceptions included in the report.

G. Certificate of Compliance: Certificate from the manufacturer of the material or equipment identifying said manufacturer, product and stating that the mateiral or equipment meet specified standards, and shall be signed by a designated officer of the manufacturer.

H. Standard Compliance: Condition whereby specified materials or equipment must conform to the standards of organizations such as the American National Standard Institute (ANSI), American Society for Testing and Materials (ASTM), Underwriters Laboratories (UL) or similar organization.

I. Quality Assurance: The day-to-day, in-process supervisory observations of work and materials conducted by the Contractor to assure that the proper methods and materials are being used and installed by tradesmen.

J. Source Quality Control: The in-process testing and inspections conducted by the QCS Inspector(s) to verify that the materials, equipment; workmanship and shop manufactured constructs are in compliance with the Contract Documents, applicable Codes and standards.

K. Field Quality Control: The testing and inspections conducted by the QCS Inspector(s) in the field during and at the completion of each construct to verify that the in-process and completed construction is in compliance with the Contract Documents, applicable Codes and standards.

L. Special Inspector – A qualified individual employed or retained by an approved agency and approved by the local governing authorities having jurisdiction (AHJ) as having the competency necessary to inspect a particular type of construction requiring special inspection.

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined signify compliance with the specification. Include a detailed, written justification for each deviation. Failure to include a copy of this marked-up specification section, along with justification(s) for requested deviations, with the submittal, is cause for rejection of the entire submittal with no further consideration.
   4. Written description of Contractor's proposed QCS plan in sufficient detail to illustrate adequate measures for verification and conformance to defined requirements. The QCS plan and submittal shall include a log showing anticipated inspections, QCS Inspectors, Special Inspections, and source and field Quality Assurance procedures. Submittal of the QCS plan shall be made prior to commencing field work.
   5. Contractor's proposed QCS Supervisor and QCS Inspectors (other than the Special Inspectors provided by Owner), including qualifications, responsibilities, and if requested, references.
   6. Complete structural system information describing Contractor designed structural systems, including sealed calculations, shop and erection drawings, product literature for the various components, International Code Council (ICC) Evaluation Reports for structural components, and a discussion of risk issues associated with the proposed system which could adversely impact overall project completion.
   7. If requested by the Construction Manager or Resident Project Representative (RPR) during the work, manufacturer's field services and reports.

A. Informational Submittals:
   1. Procedures: Section 01 33 00.
   2. Manufacturers' field services and reports unless requested by Construction Manager to be submitted for review.
   3. Special Inspection reports, unless otherwise directed in each technical specification Section.

1.05 REGULATORY REQUIREMENTS

A. GENERAL: Comply with all Federal, State, and local Codes as referenced herein. Such regulations apply to activities including, but not limited to, site work and zoning, building practices and quality, on and offsite disposal, safety, sanitation, nuisance, and environmental quality.

B. SPECIAL INSPECTION: Special Inspection shall be performed by the Special Inspector under contract with the Owner or registered design professional in responsible charge acting as the Owner's agent in conformance with the IBC. Special Inspection is in addition to, but not replacing, other inspections and quality control requirements herein. Where sampling and testing required herein conforms to Special Inspection standards, such sampling and testing need not be duplicated.

C. STRUCTURAL OBSERVATION: Registered Design Professional shall make visual inspections of the work to assess general conformance with the Contract Documents at significant construction stages and at completion of the structural system in accordance with IBC 1704.6 Structural Observations requirements.

1.06 CONTRACTOR'S RESPONSIBILITIES

A. Monitor quality assurance over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

B. Coordinate with, schedule specified inspections by, and provide normal and customary assistance to the QCS Inspectors and Owner provided Special Inspectors.

C. Coordinate with, schedule specified structural observations by Engineer, and provide normal and customary assistance to Engineer performing structural observations.

D. Comply fully with manufacturers' instructions, including each step in sequence.

E. Should manufacturers' instructions conflict with Contract Documents, request clarification before proceeding from Construction Manager.

F. Comply with specified standards as a minimum quality for the work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

G. The Contractor shall retain the services of a licensed land surveyor, registered in the State of Arizona, to perform survey work including but not limited to establishing line and grade, in advance of the construction; and to perform other surveying services for the work included under the Contract. The surveyor to be retained by the Contractor shall not be the same surveyor engaged for the Engineer's use. The surveyor shall be subject to the approval of the Engineer. Survey drawings shall be submitted to the Engineer for approval.

H. The Contractor shall take all necessary measurements in the field to verify pertinent data and dimensions shown on the Drawings or to determine the exact dimensions of the Work.

1.07 FIELD SAMPLE PROCEDURES

A. When field samples are specified in a unit of work, construct each field sample to include work of all trades required to complete the field sample prior to starting related field work. Field samples may be incorporated into the project after acceptance by Construction Manager. Remove unacceptable field samples when directed by Construction Manager. Acceptable samples represent a quality level for the work.

1.08 CONTRACTOR DESIGNED STRUCTURAL SYSTEMS

A. DESIGN ENGINEERING: Contractor shall employ and pay for engineering services from a Professional Engineer registered in the State of Arizona for structural design of Contractor designed structural systems including but not limited to temporary shoring and bracing, formwork support, interior wall and ceiling systems, and support systems for fire sprinkler, plumbing, mechanical, and electrical systems and equipment.

B. TESTS AND INSPECTIONS OF CONTRACTOR DESIGNED STRUCTURAL SYSTEMS: Contractor shall pay for preliminary testing of concrete, grout, and mortar mix designs where required by Code or these specifications prior to start of work. Contractor shall pay for required shop and site inspection of Contractor designed structural systems where required by Code or these specifications.

1.09 JOB SITE CONDITIONS

A. Schedule to ensure all preparatory work has been accomplished prior to proceeding with current work. Proceeding with the work constitutes acceptance of conditions. Allow adequate time for materials susceptible to temperature and humidity to “stabilize” prior to installation. Establish and maintain environmental conditions (i.e., temperature, humidity, lighting) as recommended by the various material manufacturers for the duration of the work.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. CONTRACTOR RESPONSIBILITIES: Provide source quality control according to the reviewed and accepted QCS plan and paragraph 1.06 herein. Coordinate with RPR or Construction Manager to facilitate the work of the Testing Laboratory specified in Section 01 45 23 and Special Inspector. Provide ready access to sampling and inspection locations and incidental labor customary in such sampling and inspections. Timely prepare and submit submittals, and revise as indicated by review comments. Comply with technical requirements in each specification Section that applies to the work.

B. CONSTRUCTION MANAGER RESPONSIBILITIES: Review Contractor's tracking of QCS activities at monthly meetings. Facilitate completion of submittal review per Section 01 33 00. Assist Contractor to ensure that Special Inspection occurs where and when specified.

C. RESIDENT PROJECT REPRESENTATVIE RESPONSIBLITIES: Assist the Construction Manager with review of Contractor's tracking of QCS activities at weekly meetings. Assist Construction Manager and Contractor to ensure that Special Inspection occurs where and when specified.

D. ACCEPTANCE CRITERIA: Acceptable characteristics and quality of a particular item or construct is defined in that item's or construct's specification Section.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Field quality control responsibilities of the Contractor and Construction Manager are substantially the same as described in paragraph 2.01, with the exception that this work occurs primarily on the jobsite as the work progresses, and Special Inspection will occur more often than at the source.

B. Acceptable characteristics and quality of a particular item or construct is defined in that item's or construct's specification Section.

3.02 REGULATORY COMPLIANCE – SPECIAL INSPECTIONS

A. The types of work requiring Special Inspection are specified in the Construction Documents and required to obtain regulatory approval by State or required by local governing authorities having jurisdiction over the building permit of the project.

B. Section 01 45 23 describes Testing Laboratory sampling, testing and reporting.

C. Contractor designed structural systems are subject to the same Special Inspection requirements as all other work.

3.03 CORRECTION OF DEFECTIVE WORK

A. Any defective or imperfect Work, equipment, or materials furnished by the Contractor which is discovered before the Final Acceptance of the Work, or during a warranty period, shall be removed immediately even though it may have been overlooked by the Engineer and approved for payment. The Contractor shall repair such defect, without compensation, in a manner satisfactory to the Engineer.

B. Unsuitable materials and equipment may be rejected, notwithstanding that such defective Work, materials and equipment may have been previously overlooked by the Engineer and accepted or approved for payment.

C. If any workmanship, materials or equipment shall be rejected by the Engineer as unsuitable or not in conformity with the Specifications or Drawings, the Contractor shall promptly replace such materials and equipment with acceptable materials and equipment at no additional cost to Owner. Equipment or materials rejected by the Engineer shall be tagged as such and shall be immediately removed from the site.

D. The Engineer may order tests of imperfect or damaged Work equipment, or materials to determine the required functional capability for possible acceptance, if there is no other reason for rejection. The cost of such tests shall be borne by the Contractor, and the nature, tester, extent and supervision of the tests will be as determined by the Engineer. If the results of the tests indicate that the required functional capability of the Work, equipment, or material was not impaired, the Work, equipment or materials may be deemed acceptable, in the discretion of the Engineer. If the results of such tests reveal that the required functional capability of the questionable Work, equipment or materials has been impaired, then such Work, equipment or materials shall be deemed imperfect and shall be replaced. The Contractor may elect to replace the imperfect Work, equipment or material in lieu of performing the tests.

END OF SECTION

SECTION 01 45 20

EQUIPMENT AND SYSTEM PERFORMANCE AND OPERATIONAL TESTING

PART 1 GENERAL

1.01 DESCRIPTION

A. This section contains requirements for the Contractor's performance in documenting testing work required under this contract. In addition, this section contains requirements for the Contractor's performance during installed performance testing of all mechanical, electrical, instrumentation, and HVAC equipment and systems, including structures for watertight construction, provided under this contract. This section supplements but does not supersede specific testing requirements found elsewhere in this project manual.

1.02 QUALITY ASSURANCE

A. Contractor's Quality Assurance Manager:
   1. The Contractor shall appoint an operations engineer or equally qualified operations specialist as Quality Assurance Manager to manage, coordinate, and supervise the Contractor's quality assurance program. The Quality Assurance Manager shall have at least 5 years of total experience, or experience on at least five separate projects, in managing the startup commissioning of mechanical, electrical, instrumentation, HVAC, and piping systems. Operations engineers shall be graduates from a minimum 4-year course in mechanical or civil engineering. Operations specialists shall have equivalent experience in plant operation and maintenance. The quality assurance program shall include:
      a. A testing plan setting forth the sequence in which all testing work required under this project manual will be implemented.
      b. A documentation program to record the results of all equipment and system tests.
      c. An installed performance testing program for all mechanical, electrical, instrumentation, and HVAC equipment and systems installed under this contract.
      d. A calibration program for all instruments, meters, monitors, gages, and thermometers installed under this contract.
      e. A calibration program for all instruments, gages, meters, and thermometers used for determining the performance of equipment and systems installed under this contract.
      f. A testing schedule conforming to the requirements specified in paragraph 2.02 Testing Schedule.
   2. For the purposes of this section, a system shall include all items of equipment, devices and appurtenances connected in such a fashion as their operation or function complements, protects or controls the operation or function of the others. The Quality Assurance Manager shall coordinate the activities of all subcontractors and suppliers to implement the requirements of this section.

B. Calibration:

1. All test equipment (gages, meters, thermometers, analysis instruments, and other equipment) used for calibrating or verifying the performance of equipment installed under this contract shall be calibrated to within plus or minus 2 percent of actual value at full scale. Test equipment employed for individual test runs shall be selected so that expected values as indicated by the detailed performance specifications will fall between 60 and 85 percent of full scale. Pressure gages shall be calibrated in accordance with ANSI/ASME B40.1. Thermometers shall be calibrated in accordance with ASTM E77 and shall be furnished with a certified calibration curve.
2. Liquid flow meters installed in pipelines with diameters greater than 2 inches shall be calibrated in situ using either the total count or dye dilution methods. Flow meter calibration work shall be performed by individuals skilled in the techniques to be employed. Calibration tests for flow metering systems shall be performed over a range of not less than 10 percent to at least 75 percent of system full scale. At least five confirmed valid data points shall be obtained within this range. Confirmed data points shall be validated by not less than three test runs with results which agree within plus or minus 2 percent.

C. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/ASME B40.1	Gauges Pressure Indicating Dial Type—Elastic Element
ASTM E77	Method for Verification and Calibration of Liquid-in-Glass Thermometers
ASHRAE 41.8	Standard Methods of Measurement of Flow of Gas

1.03 SUBMITTALS

A. Submittal material, to be submitted in accordance with Section 01 33 00, shall consist of the following:

1. A complete description of the Contractor's plan for documenting the results from the test program in conformance with the requirements of paragraph 2.02 Documentation Plans, including:

a. Proposed plan for documenting the calibration of all test instruments.
b. Proposed plan for calibration of all instrument systems, including flow meters and all temperature, pressure, weight, and analysis systems.
c. Sample forms for documenting the results of field pressure and performance tests.

2. The credentials and certification of the testing laboratory proposed by the Contractor for calibration of all test equipment.
3. Preoperational check-out procedures, reviewed and approved by the respective equipment manufacturers.
4. Detailed testing plans, setting forth step-by-step descriptions of the procedures proposed by the Contractor for the systematic testing of all equipment and systems installed under this contract.
5. A schedule and subsequent updates, presenting the Contractor's plan for testing the equipment and systems installed under this contract.
6. A schedule establishing the expected time period (calendar dates) when the Contractor plans to commence operational testing of the completed systems, along with a description of the temporary systems and installations planned to allow operational testing to take place.
7. A summary of the Quality Assurance Manager's qualifications, showing conformance to paragraph 1.02 Contractor's Quality Assurance Manager requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. The Contractor shall prepare test plans and documentation plans as specified in the following paragraphs. The Construction Manager will not witness any test work for the purpose of acceptance until all test documentation and calibration plans and the specified system or equipment test plans have been submitted and accepted.

2.02 DOCUMENTATION

A. Documentation Plans:
1. The Contractor shall develop a records keeping system to document compliance with the requirements of this Section. Calibration documentation shall include identification (by make, manufacturer, model, and serial number) of all test equipment, date of original calibration, subsequent calibrations, calibration method, and test laboratory.
2. Equipment and system documentation shall include date of test, equipment number or system name, nature of test, test objectives, test results, test instruments employed for the test and signature spaces for the Construction manager's witness and the Contractor's quality assurance manager. A separate file shall be established for each system and item of equipment. These files shall include the following information as a minimum:
a. Metallurgical tests
b. Factory performance tests
c. Accelerometer recordings made during shipment

d. Field calibration tests[1]
e. Field pressure tests[1]
f. Field performance tests[1]
g. Field operational tests[1]

3. Section 01 99 90 contains samples showing the format and level of detail required for the documentation forms. The Contractor is advised that these are samples only and are not specific to this project nor to any item of equipment or system to be installed under this contract. The Contractor shall develop test documentation forms specific to each item of equipment and system installed under this contract. Acceptable documentation forms for all systems and items of equipment shall be produced for review by the Construction Manager as a condition precedent to the Contractor's receipt of progress payments in excess of 50 percent of the contract amount. Once the Construction Manager has reviewed and taken no exception to the forms proposed by the Contractor, the Contractor shall produce sufficient forms, at his expense, to provide documentation of all testing work to be conducted as a part of this contract.

B. Test Plans:

1. The Contractor shall develop test plans detailing the coordinated, sequential testing of each item of equipment and system installed under this contract. Each test plan shall be specific to the item of equipment or system to be tested. Test plans shall identify by specific equipment or tag number each device or control station to be manipulated or observed during the test procedure and the specific results to be observed or obtained. Test plans shall also be specific as to support systems required to complete the test work, temporary systems required during the test work, subcontractors' and manufacturers' representatives to be present and expected test duration. As a minimum, the test plans shall include the following features:
   a. Step-by-step proving procedure for all control and electrical circuits by imposing low voltage currents and using appropriate indicators to affirm that the circuit is properly identified and connected to the proper device.
   b. Calibration of all analysis instruments and control sensors.
   c. Performance testing of each individual item of mechanical, electrical, and instrumentation equipment. Performance tests shall be selected to duplicate the operating conditions described in the project manual.
   d. System tests designed to duplicate, as closely as possible, operating conditions described in the project manual.
2. Test plans shall contain a complete description of the procedures to be employed to achieve the desired test environment.

[1]Each of these tests is required even though not specifically noted in detailed specification section.

3. As a condition precedent to receiving progress payments in excess of 75 percent of the contract amount, or in any event, progress payments due to the Contractor eight weeks in advance of the date the Contractor wishes to begin any testing work (whichever occurs earliest in the project schedule), the Contractor shall have submitted all test plans required for the systematic field performance and operational tests for all equipment and systems installed under this contract. Once the Construction Manager has reviewed and taken no exception to the Contractor's test plans, the Contractor shall reproduce the plans in sufficient number for the Contractor's purposes and an additional ten copies for delivery to the Construction Manager. No test work shall begin until the Contractor has delivered the specified number of final test plans to the Construction Manager.

C. Testing Schedule:
   1. The Contractor shall produce a testing schedule setting forth the sequence contemplated for performing the test work. The schedule shall be in bar chart form, plotted against calendar time, shall detail the equipment and systems to be tested, and shall be coordinated with the Contractor's construction schedule specified in Section 01 32 16. The schedule shall show the contemplated start date, duration of the test and completion of each test. The test schedule shall be submitted no later than 4 weeks in advance of the date testing is to begin. The Construction Manager will not witness any testing work for the purpose of acceptance until the Contractor has submitted a schedule to which the Construction Manager takes no exception. The test schedule shall be updated weekly, showing actual dates of test work, indicating systems and equipment testing completed satisfactorily and meeting the requirements of this project manual.

2.03 SYSTEM AND EQUIPMENT PERFORMANCE TESTS

A. Each item of mechanical, electrical, instrumentation, and HVAC equipment installed under this contract shall be tested to demonstrate compliance with the performance requirements of this project manual. Each electrical, instrumentation, mechanical, piping, and HVAC system installed or modified under this contract shall be tested in accordance with the requirements of this project manual.

2.04 OPERATIONAL TESTS

A. Once all equipment and systems have been tested individually, the Contractor shall fill all systems with potable water. After filling operations have been completed, the Contractor shall operate all systems for a continuous period of not less than 30 days, simulating actual operating conditions to the greatest extent possible. The Contractor shall install temporary connections, bulkheads and make other provisions to recirculate process fluids or otherwise simulate anticipated operating conditions. During the operational testing period, the Contractor's Quality Assurance Manager and testing team shall monitor the characteristics of each machine and system and report any unusual conditions to the Construction Manager.

2.05 PRODUCT DATA

A. Product data, to be provided in accordance with Section 01 33 00, shall be the original and three copies of all records produced during the testing program.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor's quality control manager shall organize teams made up of qualified representatives of equipment suppliers, subcontractors, the Contractor's independent testing laboratory, and others, as appropriate, to efficiently and expeditiously calibrate and test the equipment and systems installed and constructed under this contract. The objective of the testing program shall be to demonstrate, to the Construction Manager's complete satisfaction, that the structures, systems, and equipment constructed and installed under this contract meet all performance requirements and the facility is ready for the commissioning process to commence. In addition, the testing program shall produce baseline operating conditions for the Owner to use in a preventive maintenance program.

3.02 CALIBRATION OF FIXED INSTRUMENTS

A. Calibration of analysis instruments, sensors, gages, and meters installed under this contract shall proceed on a system-by-system basis. No equipment or system performance acceptance tests shall be performed until instruments, gages, and meters to be installed in that particular system have been calibrated and the calibration work has been witnessed by the Construction Manager.

B. All analysis instruments, sensors, gages, and meters used for performance testing shall be subject to recalibration to confirm accuracy after completion, but prior to acceptance of each performance test. All analysis instruments, sensors, gages, and meters installed under this contract shall be subject to recalibration as a condition precedent to commissioning under the provisions of Section 01 91 00.

3.03 PERFORMANCE TESTS

A. General:
   1. Performance tests shall consist of the following:
      a. Pressure and/or leakage tests.
      b. Electrical testing as specified in Division 26.
      c. Wiring and piping, individual component, loop, loop commissioning and tuning testing as described in Division 40.
      d. Preoperational checkout for all mechanical and HVAC equipment. Preoperational check-out procedures shall be reviewed and approved by the respective equipment manufacturers.
      e. Initial operation tests of all mechanical, electrical, HVAC, and instrumentation equipment and systems to demonstrate compliance with the performance requirements of this project manual.
   2. In general, performance tests for any individual system shall be performed in the order listed above. The order may be altered only on the specific written authorization of the Construction Manager after receipt of a written request, complete with justification of the need for the change in sequence.

B. Pressure And Leakage Tests:
   1. Pressure and leakage tests shall be conducted in accordance with applicable portions of Divisions 3 and 40. All acceptance tests shall be witnessed by the Construction Manager. Evidence of successful completion of the pressure and leakage tests shall be the Construction Manager's signature on the test forms prepared by the Contractor.

C. Functional Checkout:
   1. Prior to energization (in the case of electrical systems and equipment), all circuits shall be rung out and tested for continuity and shielding in accordance with the procedures required in Division 26.

D. Component Calibration And Loop Testing:
   1. Prior to energization (in the case of instrumentation system and equipment), all loops and associated instruments shall be calibrated and tested in accordance with the procedures required in Division 40.

E. Electrical Resistance:
   1. Electrical resistance testing shall be in accordance with Division 26.

F. Preoperational Tests:
   1. Preoperational tests shall include the following:
      a. Alignment of equipment using reverse dial indicator method.
      b. Pre-operation lubrication.
      c. Tests per the manufacturers' recommendations for prestart preparation and preoperational check-out procedures.

G. Functional Tests:
   1. General: Once all affected equipment has been subjected to the required preoperational check-out procedures and the Construction Manager has witnessed and has not found deficiencies in that portion of the work, individual items of equipment and systems may be started and operated under simulated operating conditions to determine as nearly as possible whether the equipment and systems meet the requirements of these specifications. If available, plant effluent may be employed for the testing of all liquid systems except gaseous, oil, or chemical systems. If not available, potable water shall be employed as the test medium. Test media for these systems shall either be the intended fluid or a compatible substitute. The equipment shall be operated a sufficient period of time to determine machine operating characteristics, including noise, temperatures and vibration; to observe performance characteristics; and to permit initial adjustment of operating controls. When testing requires the availability of auxiliary systems such as looped piping, electrical power, compressed air, control air, or instrumentation which have not yet been placed in service, the Contractor shall provide acceptable substitute sources, capable of meeting the requirements of the machine, device, or system at no additional cost to the Owner. Disposal methods for test media shall be subject to review by the Construction Manager. During the functional test period, the Contractor shall obtain baseline operating data on all equipment with motors greater than 1 horsepower to include amperage, bearing temperatures, and vibration. The baseline data shall be collected for the Owner to enter in a preventive maintenance system.

a. Test results shall be within the tolerances set forth in the detailed specification sections of this project manual. If no tolerances have been specified, test results shall conform to tolerances established by recognized industry practice. Where, in the case of an otherwise satisfactory functional test, any doubt, dispute, or difference should arise between the Construction Manager and the Contractor regarding the test results or the methods or equipment used in the performance of such test, then the Construction Manager may order the test to be repeated. If the repeat test, using such modified methods or equipment as the Construction Manager may require, confirms the previous test, then all costs in connection with the repeat test will be paid by the Owner. Otherwise, the costs shall be borne by the Contractor. Where the results of any functional test fail to comply with the contract requirements for such test, then such repeat tests as may be necessary to achieve the contract requirements shall be made by the Contractor at his expense.

b. The Contractor shall provide, at no expense to the Owner, all power, fuel, compressed air supplies, water, and chemicals, all labor, temporary piping, heating, ventilating, and air conditioning for any areas where permanent facilities are not complete and operable at the time of functional tests, and all other items and work required to complete the functional tests. Temporary facilities shall be maintained until permanent systems are in service.

2. Retesting: If under test, any portion of the work should fail to fulfill the contract requirements and is adjusted, altered, renewed, or replaced, tests on that portion when so adjusted, altered, removed, or replaced, together with all other portions of the work as are affected thereby, shall, unless otherwise directed by the Construction Manager, be repeated within reasonable time and in accordance with the specified conditions. The Contractor shall pay to the Owner all reasonable expenses incurred by the Owner, including the costs of the Construction Manager, as a result of repeating such tests.

3. Post-test Inspection: Once functional testing has been completed, all machines shall be rechecked for proper alignment and realigned, as required. All equipment shall be checked for loose connections, unusual movement, or other indications of improper operating characteristics. Any deficiencies shall be corrected to the satisfaction of the Construction Manager. All machines or devices which exhibit unusual or unacceptable operating characteristics shall be disassembled and inspected. Any defects found during the course of the inspection shall be repaired or the specific part or entire equipment item shall be replaced to the complete satisfaction of the Construction Manager at no cost to the Owner.

3.04 OPERATIONAL TESTS

A. The Contractor shall provide system operation testing. After completion of all performance testing and certification by the Construction Manager that all equipment complies with the requirements of the specifications, the Contractor shall fill all process units and process systems with potable water.

B. Upon completion of the filling operations, the Contractor shall circulate water through the completed facility for a period of not less than 48 hours, during which all parts of the system shall be operated as a complete facility at various loading conditions, as directed by the Construction Manager. The operational testing period shall commence after this initial period of variable operation. Should the operational testing period be halted for any reason related to the facilities constructed or the equipment furnished under this contract, or the Contractor's temporary testing systems, the operational testing program shall be repeated until the specified continuous period has been accomplished without interruption. All process units shall be brought to full operating conditions, including temperature, pressure, and flow.

C. Contrator shall coordinate and pay for all water quality testing to ensure that the treatment plant is meeting primary and secondary Navajo Nation EPA drinking water standards.

D. As-built documents specified in Section 01 78 39 of facilities involved shall be accepted and ready for turnover to the Owner at the time of operational testing.

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SECTION 01 45 23

TESTING AND INSPECTION SERVICES

PART 1 GENERAL

1.01 SUMMARY

A. GENERAL REQUIREMENTS: Comply with the testing and inspection specified in this Section and elsewhere in the Construction Documents. For the purpose of this Section, all references made herein to Testing Agency or Special Inspector or Geotechnical Consulting Firm shall be referred to as those tests or inspections which will be conducted by an inspector provided by the Owner.

1. The Contractor will select and employ an independent Testing Agency(s) to conduct the tests and inspections in accordance with applicable standard methods of American Society for Testing and Materials (ASTM) or other standards specified by the local governing authorities having jurisdiction (AHJ). The Owner may require other special inspection services to inspect and verify the Work installed is in accordance with the Construction Documents and construction industry standards.
2. The Contractor shall provide and pay for other inspection and testing services where specified in the Construction Documents or required to obtain regulatory approval by the Navajo Nation or AHJ.

1.02 DEFINITIONS

A. Special Inspector – A qualified individual employed or retained by an approved agency and approved by the Owner's Engineer as having the competency necessary to inspect a particular type of construction requiring special inspection.

B. Testing Agency - firm responsible for performing specific inspections and/or tests as part of the Testing and Special Inspection program.

1.03 QUALITY ASSURANCE

A. QUALIFICATIONS: The inspector for all Work as hereinafter specified, except for geotechnical inspections, waterproofing and roofing, shall be a registered Special Inspector employed by an approved inspection and/or Testing Agency. All inspection personnel used on this Project are subject to being disapproved from the Project at the discretion of the Owner and the Owner's Engineer.

1. The Special Inspector shall have the required technical knowledge and experience for the product or construction element being installed.
2. Geotechnical Inspection will be performed by a licensed Geotechnical Consulting Firm.

1.04 DUTIES OF CONTRACTOR'S TESTING AGENCY

A. GENERAL: The Contractor's Testing Agency will conduct testing and inspection services, interpret them, and evaluate the results for compliance with the construction permitand the Construction Documents; agency will report findings to the Owner's Engineer, Construction Manager, and Resident Project Representative (RPR), and Contractor. Testing and inspection services shall be in accordance with applicable standard methods of ASTM or other standards specified by AHJ, the Construction Documents, and construction industry standards. The Testing Agency will reasonably support overtime, second shift, and out-of-area activity if needed by the Contractor.

B. TESTING AND INSPECTION: Materials to be tested are specified in the Construction Documents, or required by the Owner's Engineer. Quantities and extent of tests and inspections shall be as specified and/or required by the Owner's RPR.

C. NON-CONFORMING WORK: The Owner's RPR shall document and immediately notify the Contractor, Construction Manager, and Owner of any Work found defective or not in accordance with the requirements of the Construction Documents. Non-conforming Work shall be corrected.

D. The Contractor's inspectors are not authorized to do the following:
   1. Release, revoke, alter or enlarge on requirements of Construction Documents.
   2. Approve or accept any portion of the Work,
   3. Perform any duties of the Contractor.
   4. Stop Work.

1.05 COSTS

A. The Contractor's Testing Agency(s) and Special Inspector costs for initial testing and inspection as specified in the Construction Documents will be paid for by the Contractor. Initial tests and inspections are defined as those required to complete the first tests and inspections specified. Costs for subsequent re-testing and re-inspection of items found not to be in compliance with Construction Documents shall be borne by the Contractor.

B. Additional tests and inspections not herein specified, but requested by the Owner, shall be paid for by the Owner. However, if the results of such tests or inspections are found to be not in compliance with Construction Documents, the Contractor will be back charged for all costs for initial testing as well as re-testing, re-inspection and Owner's Consultants services.

C. Costs for additional tests or inspections required because of Contractor changes to reviewed and accepted products or materials provided, or source, or supply shall be borne by the Contractor.

D. Costs for any Work which is required to correct any deficiencies shall be borne by the Contractor.

E. Costs of any testing which is required solely for the convenience of Contractor in its scheduling and performance of the Work shall be borne by the Contractor.

F. Costs for verification testing of Work done without prior notice, with improper supervision, or contrary to construction practice shall be borne by the Contractor.

G. Costs for testing of materials for which fabrication and mill reports are required but not furnished shall be borne by the Contractor.

H. The cost, if any, of providing access for inspections and tests shall be considered part of the normal expense of conducting business and therefore non-reimbursable.

I. In those instances where inspector(s) arrive at the agreed-upon location, at the agreed upon date and time, and find articles to be inspected are not ready for inspection, the inspector(s) shall return to their home office and all expenses incurred shall be borne by the Contractor.

1.06 TESTS AND INSPECTION REPORTS

A. Copies of Contractor and Owner test and inspection reports shall be distributed at weekly intervals. All reports will be signed by a certified Special Inspector or Professional Engineer registered in the State of Arizona, as appropriate. Such reports shall include all tests made, regardless of whether such tests indicate that the material is satisfactory or unsatisfactory; a final report should be submitted documenting corrective work done on of any unsatisfactory material and or work identified in the testing or inspection reports. Samples taken, but not tested, shall also be reported. Records of special sampling operations that are required shall also be reported. Test and inspection reports shall be distributed as follows:
   1. Owner's Engineer, Construction Manager, and RPR
   2. Contractor
   3. Authority Having Jurisdiction

B. A report shall be prepared for each inspection and test and shall include:
   1. Date issued.
   2. Project title and number.
   3. Name and signature of inspector.
   4. Date of inspection or sampling and test.
   5. Record of temperature and weather.
   6. Identification of product and Specification Section.
   7. Location in Project.
   8. Type of inspection or test.
   9. Results of inspections and tests, and observations regarding compliance with Laws and Regulations, and standards.

1.07 CONTRACTOR'S RESPONSIBILITIES

A. COORDINATION: It is the Contractor's responsibility to initiate, coordinate, and conform to the required tests and inspections of Contract Documents. Inspection of the Work by the Contractor's Special Inspectors and/or Testing Agency shall not relieve the Contractor from responsibility for compliance with the Construction Documents requirements. Owner's Special Inspectors and/or Testing Agency and Owner shall have authority to reject Work whenever the provisions of the Construction Documents are not being complied with, and the Contractor shall instruct their employees accordingly.

B. ACCESS FOR THE PURPOSE OF INSPECTION: Ensure the Contractor's Special Inspectors and/or Testing Agency and Owner's Special Inspectors have free access to all parts of the Work and to the shops where the Work is in preparation; are provided proper facilities and safe access for such inspection; and are reasonably furnished access, equipment, tools, samples, certifications, test reports, design mixes, storage, and assistance as requested by the Owner's RPR.

C. STORAGE FACILITIES: Furnish adequate storage facilities as approved by the Owner's RPRfor the sole use of the Contractor's Testing Agency for safe storage and curing of such specimens which must remain on the site prior to transport to the laboratory.

D. DATA: Furnish records, Contract Drawings and shop drawings, certificates, approved Change Orders, and similar data as required by Owner's Inspectors to perform their work to assure compliance with the Construction Documents.

E. NOTICE: Furnish notice to Owner's RPR and coordinate with Owner's Inspectors a minimum of five (5) working days in advance of all required tests and a minimum of forty-eight (48) hours in advance of all required inspections, unless otherwise specified.

F. NON-CONFORMING WORK: Remove and replace Non-conforming Work at no additional cost to the Owner prior to Final Completion. Where Non-conforming Work requires design modifications, such re-design shall be performed by the Engineer of Record and costs shall be borne by the Contractor.

G. CANCELLATIONS: Contractor shall give sufficient advance notice to Owner's RPR and Inspectors to allow rescheduling of their work load in the event of cancellation or time extension of any scheduled test or inspection

1.08 TEST FAILURES

A. GENERAL: The Owner's Engineer or RPR may require re-test of a sampled material when a sample or procedure has failed to pass the required tests. In the event any test or inspection indicates failure of a material or procedure to meet requirements of Construction Documents, all costs for re-testing or re-inspection shall be borne by the Contractor. The Contractor may opt to replace the imperfect Work, equipment or material in lieu of performing the tests.

1.09 REPORT TEST FAILURES

A. GENERAL: Immediately upon determination of a test failure, the Contractor's Inspector shall notify the Owner and Contractor. By the end of the following day the Contractor's Inspector shall send written test results to those named on the distribution list.

B. Contractor shall similarly report test failures to Owner resulting from work of testing agencies provided by the Contractor.

PART 2 - NOT USED

PART 3 - EXECUTION

A. Contractor shall complete field testing in accordance with the minimum requirements indicated in the following schedule and throughout the Contract Documents. Additional source material testing shall be complete as necessary to establish the basis of field tests. The frequency of testing in this schedule lists the minimum number of tests to be requested and completed per quantity of work completed by the Contractor and should be verified in the individual Specifications sections. See the Statement of Special Inspections in the General Structural Notes for additional information and requirements.

B. FILL
   1. SUBGRADE PREPARATION AND COMPACTION: Verify depth of scarification, moisture content within optimal limits for compaction, and degree of compaction specified in Section 31 23 00. Frequency of testing shall generally conform to 25 foot maximum spacing for strip footings, each isolated pad footing, every 900 square feet for slabs and mat foundations, or as directed by the RPR in light of actual geometry and conditions extent.
   2. STRUCTURE FILL: Verify material provided, lift thickness, and compaction density. Frequency of sampling and testing shall be the same as for Subgrade Preparation and Compaction.
   3. STRUCTURE BACKFILL: Verify material provided, lift thickness, and compaction density. Frequency of sampling and testing shall be as directed by the RPR but not less than every 2 feet vertical (lifts) and every 1600 square feet of filled area.
   4. PIPE TRENCH BACKFILL: Verify material provided, lift thickness, and compaction density. Frequency of sampling and testing for Bedding, pipe zone, and trench back fill shall be at performed intervals no greater than 500 feet. Testing at minimum shall be performed at the spring line on both sides of the pipe and at 12-inches above the crown of the pipe.
   5. OTHER FILL MATERIALS: Verify material used, lift thickness, and compaction density. Frequency of sampling and testing shall be as directed by the RPR or Construction Manager.

C. CONCRETE REINFORCING
   1. Provide Special Inspection for all structural reinforcing in concrete and masonry.
   2. Provide Special Inspection for mechanical reinforcing connectors and splicing systems as required by that product's ICBO Evaluation Report, or equivalent.

D. CAST-IN-PLACE CONCRETE

1. Sample the first daily truck load of ready mixed concrete and every 50 cubic yards thereafter, complying with ASTMC 172.
2. Perform one slump test for the first daily truck load of ready mixed concrete and every 50 cubic yards thereafter or as requested by RPR or Construction Manager if consistency is in question, complying with ASTM C143.
3. Perform one air content test for each set of compressive strength specimens, complying with ASTM C 31.
4. Fabricate compressive strength specimens, complying with ASTM C 39.
5. Make one set of 6 of compressive strength specimens for each day of structural concrete placing or each 150 cubic yards or fraction thereof for each class of concrete.
6. Test two specimens after curing 7 days, two specimens after curing 28 days, and retain two specimens for later testing if required.
7. Comply with ACI 350 Section 5.6 (ACI 318 for non-water retaining structures) for evaluation and acceptance of concrete.

E. ANCHOR BOLTS AND ANCHORS

1. SPECIAL INSPECTIONS: Provide Special Inspection for wedge anchors, undercut anchors, adhesive anchors, epoxy anchors, and all other anchoring systems installed in hardened concrete and masonry as required by that product's ICBO Evaluation Report, or equivalent.
2. SITE INSPECTION OF STRUCTURAL ANCHOR BOLTS: Visually inspect all structural anchor bolts for grade, diameter, embedment, geometry or type ("J" bolt or hex-head), quantity and general location. Contractor shall assume all responsibility for detailed dimensions locating each individual bolt, each bolt group in total, and locations of bolts within each group (template).

F. STRUCTURAL METALS

1. SHOP WELD INSPECTION FOR STRUCTURAL STEEL, AND STEEL FABRICATIONS: AWS Certified Welding Inspector shall visually inspect 100 percent of structural welds and will inspect 25 percent of fillet welds greater than 5/16 inch, 100 percent of butt welds, moment connection welds, and full penetration groove welds by ultra-sonic or magnetic particle inspection. Acceptance Criteria: AWS D 1.1. Paragraph 8.15.1 for visual inspection and Paragraphs 8.15.2.1 and 8.15.2.2 for ultra-sonic or magnetic particle inspection.
2. SHOP INSPECTION OF HIGH-STRENGTH BOLTED CONNECTIONS: Special Inspector - inspect 100 percent of high-strength bolted connections according to AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts." All such bolts shall be fully tensioned unless otherwise noted on the drawings.
3. MATERIALS' CONFORMANCE TO SPECIFICATIONS: Special Inspector shall sample and test such items to ensure Standard Compliance for any specified steel materials, connection hardware, and details for which mill certificates or other required certificates have not been submitted. Contractor shall pay for the cost of such sampling, additional testing, and reporting.

G. ROUGH CARPENTRY

1. CONVENTIONAL FRAMING WITH SAWN LUMBER: Special Inspector visually inspect for size and grade of sawn lumber bearing wall elements, joists, rafters, and beams. Visually inspect for adequate bearing on supporting elements.
2. ENGINEERED AND MANUFACTURED WOOD JOISTS, BEAMS AND POSTS: Special Inspector visually inspect for size, type, and manufacturer's product grade for all elements using engineered and manufactured wood including glu-laminated members. Verify tension rated lamination of glu-laminated beams is properly oriented. Visually inspect for adequate bearing on supporting elements.
3. ENGINEERED WOOD TRUSSES: Special Inspector visually inspect against reviewed and accepted manufacturer's shop drawings, including general shape, chord and web sizes, bridging and bracing, and adequate bearing.
4. ROOF AND WALL SHEATHING: Special Inspector visually inspect for specified thickness and plies, Index, APA rating, strength axis across supporting members, staggered layout on roofs and floors, blocking or clips, edge nailing and field nailing.
5. CONNECTORS: Special Inspector verify bolted and nailed connections conform to specifications. In particular, visually inspect "gun nails" for conformance to specified common nail diameters and lengths. Inspect cold-formed steel framing connectors, rafter/truss ties, straps and seismic hold-downs according to ICBO Evaluation Report descriptions, controlling Code or specified standard. Inspect split ring connectors and their bolting.

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SECTION 01 52 00

CONSTRUCTION FACILITIES

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies field office equipment, and services to be provided for the Owner's Resident Project Representative (RPR) and Construction Manager at the project site during the entire time of construction.

B. General Field Office Requirements:
   1. The field office, equipped as specified herein, shall be provided at the site, ready for use by the Contractor and RPR within 30 days after the Notice to Proceed.
   2. Unless released earlier by the Construction Manager in writing, the field office shall be maintained in full operation at the site with all utilities connected and operable until the Notice of Completion has been executed or recorded. Upon execution or recordation of the Notice of Completion, or upon early release of the field office by the Construction Manager the Contractor shall remove the field office(s) within 14 days from the date of notification, and shall restore the site to its original condition.

C. Office Facilities:
   1. The Contractor shall provide all necessary electrical wiring, plumbing, toilet and lavatory fixtures, air conditioning and heating equipment, and shelving, and shall furnish all necessary light, heat, water, and daily janitorial services in connection with the field office specified herein, for the duration of the Work.
   2. The Contractor shall provide and maintain for the exclusive use of the RPR, Construction Manager, and the Owner's representative and personnel one, well lighted, air conditioned, electrically heated field office the equivalent to a 10-foot x 10-foot working office with a toilet room, containing a water closet and lavatory partitioned off from the working area and outside door lock. The Contractor shall provide all furnishings, services, and equipment specified herein. The office shall be of the portable trailer type unless otherwise specifically authorized by the Construction Manager in writing and shall be separate unit, not attached or connected to any other structures. The Contractor's field office will have as a minimum four private offices, one conference room and one common area.

1.02 FIELD OFFICE FURNISHINGS

A. The Contractor shall provide the following listed items in good condition for the primary field office:
   1. 4 Standard 30 x 60-inch desk with not less than 3 drawers
   2. 1 Plan table 36 x 72-inch top; 36 inches high
   3. 1 Plan rack (all metal plan-hold type) capable of holding 3 sets of plans, complete with 3 standard all metal plan-hold clamps
   4. 2 File cabinet, legal size, 4 drawer with lock and 3 keys, double suspension, complete Pendaflex suspension racks for each drawer. File cabinet must be fire resistant.

5. 4 Office chair, standard arm rest type, adjustable swivel tilt-back with casters
6. 8 Office chair, stiff-leg type, no arm rest
7. 5 Waste baskets
8. 2 Tack board 36 x 42 inches, well mounted
9. 1 Bottled water dispenser unit (supplying both hot and cold water) and bottled water service and continuous supply of paper cups
10. 1 4' x 8' conference room table
11. 2 3' x 5' office tables
12. 2 Freestanding book shelves, minimum 4 feet high. Nine linear feet of shelf space shall be provided in each.
13. 1 Whiteboard, 4' x 3' with erasable color markers and supplies.
14. 1 10-inch indoor/outdoor maximum/minimum thermometer
15. 1 Rain gauge

1.03 SPECIAL OFFICE EQUIPMENT

A. Copy Machine:
   1. The Contractor shall provide, for the use of the RPR/Construction Manager, one office copy machine.
   2. Copy machine shall be a dry, electrostatic process, capable of reproducing original 8-1/2 x 11, 8-1/2 x 14, and 11 x 17 originals on either 8-1/2 x 11, 8-1/2 x 14, or 11 x 17 plain bond paper. The copy machine shall be capable of both full-size and reduced size prints such that an 8-1/2 x 14 original can be copied on a sheet of 8-1/2 x 11 paper. The machine must have a stack-feed capability and collating capability.
   3. The Contractor shall obtain and pay for a service contract with a local representative of the copy machine vendor or manufacturer for on-site availability of a service representative for on-site service and repair. The Contractor shall furnish all necessary powders, chemicals, or other materials required for proper operation of the copy machine.

B. Printer:
   1. General: The Contractor shall provide, for use of the RPR and Construction Manager, one printer in the field office.
   2. Printer: The printer shall be Laser Writer automatic feed type.
   3. Service Contract: The Contractor shall obtain and pay for a service contract with a local representative of the dealer or manufacturer for on-site availability of a service engineer for on-site service and repair. Said service contract shall cover the printer.

1.04 FIELD INTERNET SERVICE

A. Within 45 days after the Notice to Proceed, the Contractor shall provide in the field office provided as specified herein, for the use of the PPR, Owner's or Construction Manager's employees in connection with performance of the work hereunder, working internet service.

1.05 FIELD OFFICE SERVICES

A. The field office required hereunder shall be provided with sufficient lighting to provide not less than 50 foot-candles at desk top height at each desk location. Exterior lighting shall be provided over the entrance door.

B. A minimum of four 110V AC duplex electric convenience outlets shall be provided in the office and in the conference room and common area. At least one such outlet shall be located on each wall. The electric distribution panel shall service not less than two 110V, 60 Hz circuits.

C. Where inside toilet facilities are not connected to outside plumbing, a flush-type chemical toilet with a holding tank shall be provided. All such sanitary waste material shall be regularly pumped out and the chemicals recharged. A continuous supply of toilet paper and paper towels shall be furnished for the toilet facility.

D. Regular daily janitorial services shall be furnished during working hours each day. Offices shall be swept, dusted, and waste receptacles emptied.

1.06 FIELD OFFICE UTILITIES

A. The Contractor shall make all provisions and pay all installation and other costs for the Contractor's and the RPR/Construction Manager's office(s) in order to provide internet service, power service, exterior lights and any local code and OSHA requirements. The Contractor shall pay all monthly charges for the various services provided to the RPR's/Construction Manager's office throughout the construction period.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials, equipment and furnishings may be new or used, but must be serviceable, adequate for the required purpose, and must not violate applicable codes for regulations.

PART 3 EXECUTION

3.01 PREPARATION

A. The Contractor shall fill and grade sites for temporary structures to provide surface drainage. Provide all-weather surfaced access roads and paths and parking areas.

3.02 INSTALLATION

A. The Contractor shall construct temporary field office on proper foundations and provide connections for utility services. He shall secure portable or mobile buildings when used. Steps and landings shall be provided at entrance doors and a thermometer mounted at a convenient outside location, not in direct sunlight.

3.03 LOCATION

A. The field office facilities shall be located within the Contractor's work area shown at specific site approved by the Construction Manager.

3.04 MAINTENANCE AND CLEANING

A. The Contractor shall provide periodic maintenance and weekly cleaning for field offices, furnishings, and equipment.

3.05 REMOVAL

A. The Contractor shall remove temporary field offices, workshops and storage buildings, and contents and services at a time when no longer needed. Foundations and debris shall be removed; site shall be graded to required elevations and the area cleaned.

END OF SECTION

SECTION 01 55 26

TRAFFIC CONTROL

PART 1 GENERAL

1.01 REQUIREMENTS

A. The Work specified in this Section consists of providing safe and effective work areas, alternate traffic corridors, and to warn, control, protect, and expedite vehicular and pedestrian traffic through the construction zone. It shall be the sole responsibility of the CONTRACTOR to provide for the safety of the traveling public within the limits of the project and on private property. The CONTRACTOR shall provide all labor, equipment, materials and services necessary.

B. CONTRACTOR shall indemnify and hold harmless the OWNER, ENGINEER, and the CONSTRUCTION MANAGER for any safety violation or noncompliance with governing bodies and their regulations, and for accidents, deaths, injuries, or damage at the site during occupancy or partial occupancy of the site by CONTRACTOR's workforce or equipment while performing any part of the Work.

C. In this Section, reference to the Public is to include the OWNER's personnel, representatives, and/or facilities.

D. Traffic control shall meet the requirements of the government agency (i.e., ADOT, etc.) with jurisdiction of the right-of-way in which the Work is completed and as specified in this Section. In the case of conflict between the listed Agency's requirements and as required herein, the requirements affording the greatest protection to the Public and/or OWNER shall apply, as determined by the CONSTRUCTION MANAGER.

E. The CONTRACTOR shall maintain all required traffic control devices and trenches within the right-of-way at all times, 24 hours per day, 7 days per week including nights, holidays, and weekends.

1.02 DEFINITIONS

A. LANE CLOSURE: Lane closure shall be defined as denying any lane or any portion of a lane to traffic. A lane reduced to less than 11 feet is considered a lane closure.

1.03 REFERENCES

A. This Section includes references to the following standards. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements affording the greatest protection to the OWNER shall apply, as determined by the CONSTRUCTION MANAGER.

Reference	Title
MUTCD	Manual on Uniform Traffic Control Devices, United States Department of Transportation, Federal Highway Administration (latest edition): herein referred to as MUTCD.
ADOT	Arizona Department of Transportation (ADOT) Temporary Traffic Control Design Guidelines – Traffic Engineering Group 2019.

1.04 SUBMITTALS

A. Submittals in accordance with the General Conditions and Section 01 33 00.

B. Project-specific Traffic Control Plan shall be submitted by the CONTRACTOR to the respective governmental agency with jurisdiction of the right-of-way for acceptance. Traffic Control Plans within ADOT ROW shall be prepared and stamped by a registered State of Arizona Traffic Engineer.

C. A Traffic Control Plan shall be required for each phase or segment of the construction. Each Traffic Control Plan shall be considered separately.

D. Submit two copies of the approved Traffic Control Plan to the CONSTRUCTION MANAGER within 48 hours of approval by government agencies.

1.05 BARRICADES AND ENCLOSURES

A. Protection of Workmen and Public: CONTRACTOR shall erect and maintain at all times during the prosecution of the Work, barriers and lights necessary for the protection of workmen and the public. CONTRACTOR shall provide suitable barricades, lights, signs, and watchmen at all places where the Work causes obstructions to the normal traffic or constitutes in any way a hazard to the public.

B. Barricades and Lights: CONTRACTOR shall protect all streets, roads, highways, and other public thoroughfares that are partially closed to traffic and use effective barricades that display acceptable warning signs. CONTRACTOR shall locate barricades as required by the government agency controlling the right-of-way in accordance with an approved Traffic Control Plan.

C. Statutory Requirements: CONTRACTOR shall install and maintain all barricades, signs, lights, and other protective devices within rights-of-way in strict conformity with applicable statutory requirements by the government agency having jurisdiction in accordance with an approved Traffic Control Plan.

1.06 TRAFFIC CONTROL DEVICES

A. All traffic control devices not in use, or that will not be used for a period greater than 24 hours, shall be removed by the CONTRACTOR from the work area. The sidewalk area shall not be used at any time to store unused traffic control devices unless the sidewalk is closed, and an approved barricade plan is provided for rerouting pedestrians.

B. CONTRACTOR shall maintain all barricades and other traffic control devices in clean and effective condition and replace devices in poor condition immediately.

C. CONTRACTOR shall begin placing barricades in the direction of traffic and remove them in the direction of opposing traffic.

D. Text message boards: Fixed at each end of the project set and two moveable boards within the project setup area.

1.07 FLAGGERS

A. As may be required by ADOT and respective governmental agency with jurisdiction of the right-of-way to complete the Work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials shall conform to the MUTCD, ADOT Standard Specifications and Drawings as applicable, and as specified in this section.

2.02 TEMPORARY STRIPING

A. Temporary pavement marking shall conform to the government agency with jurisdiction of the right-of-way, as applicable.

2.03 TRAFFIC CONTROL PLAN

A. At a minimum, the Traffic Control Plan shall provide, for each phase of the work, the placement and spacing of all traffic control devices (including signs, markings, channelizing devices, lighting devices, flaggers, etc.) and spacing of these meeting the requirements of the MUTCD within the following traffic control areas:
   1. Advance warning signs
   2. Transition areas
   3. Buffer spaces
   4. Work area
   5. Termination areas

B. Additionally, the Traffic Control Plan must clearly show the following minimum information:
   1. Method for protecting excavations, work sites, and school zone crosswalks
   2. Method of barricading at intersections
   3. Driveway access plan
   4. Provisions for emergency vehicle access
   5. All set-up changes to accommodate different phasing of the work
   6. Lane widths and transitions
   7. 24-hour emergency contact information
   8. Business access signs
   9. Sidewalk "closed/cross here" signs, if applicable
   10. No parking signs
   11. Project signs
   12. Fresh oil signs, if applicable
   13. Duration of traffic control and barricade plan
   14. All advance warning signs
   15. Lane closures
   16. Placement of "double penalty in work zones" warning signs

17. Detour locations
18. Contractor Staging Areas
19. Excavation locations

C. Within 48 hours after installation of new or modified control, CONTRACTOR shall inspect and certify that controls are installed and operating as intended. Certification shall consist of a signed affidavit stating that the traffic control has been inspected and found to be in conformance with the Traffic Control Plan and contract requirements were provided to the government agency with jurisdiction of the right-of-way. A copy of the certification shall be provided to the CONSTRUCTION MANAGER within 48 hours of submittal to government agencies.

D. Review and comment on the Traffic Control Plan by the government agency with jurisdiction of the right-of-way shall in no way relieve the CONTRACTOR of the responsibility for traffic and safety requirements. Such acceptance shall in no way be construed as confirmation of the technical accuracy or adequacy of the contents of the Traffic Control Plan and shall not relieve the CONTRACTOR of the obligation to institute traffic control measures in full compliance with contract requirements and in conformance with local agency requirements.

PART 3 EXECUTION

3.01 GENERAL

A. All traffic control within public rights-of-way shall conform to the requirements of the encroachment permits and traffic control plans approved by the government agency with jurisdiction in the right-of-way.

B. All traffic control on private property shall warn, control, protect, and expedite vehicular and pedestrian traffic through the private property.

C. The CONTRACTOR shall not restrict access to private and public buildings along the pipeline or temporary piping alignment.

D. If, during the execution of the work, the CONTRACTOR determines that the traffic control is not functioning as intended, the CONTRACTOR shall make revisions to the Traffic Control Plan as necessary, provided that the local agencies with jurisdiction have accepted the changes. Submit two copies and digital files of the approved revised Traffic Control Plan to the CONSTRUCTION MANAGER within 48 hours of approval by government agencies.

3.02 TEMPORARY SURFACES

A. Temporary gravel surface shall not be permitted.

B. All temporary detours and/or bypasses shall be hard surfaced with asphalt-concrete pavement (minimum thickness of a 12” base course and 3” asphalt pavement) and maintained in a smooth and usable condition at all times for the duration of the detour and/or bypass.

C. The CONTRACTOR shall be required to provide temporary surfacing of all excavated areas immediately after completing the backfilling of any section of the Work. If permitted by the government agency with jurisdiction of the right-of-way, the CONTRACTOR may be allowed to leave excavations open provided that traffic control devices, approved by the governmental agency maintaining the right-of-way, are in place and maintained, and excavations are covered with steel plates at the close of each working day. The temporary steel plates shall comply with the requirements of the governmental agency controlling the right-of-way.

3.03 TEMPORARY STRIPING

A. Placement of temporary pavement striping shall be by pilot line method and use shall be limited to 14 calendar days and spaced every 40 feet. The double yellow line shall have two pieces of tape side by side with a 4-inch space between and spaced to the above increments.

B. Painted temporary striping shall be 4 inches wide and shall be continuous or intermittent in accordance with the MUTCD. Painted temporary striping shall not be used on the existing pavement or on final wearing course of pavement.

C. Existing pavement markings, either painted or raised pavement markers, which are not applicable or are within the transverse limits of the temporary travel lanes shall be removed to the satisfaction of the CONSTRUCTION MANAGER. Painting over existing markings is not permitted.

END OF SECTION

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SECTION 01 57 23

STORM WATER POLLUTION PREVENTION PLAN (SWPPP)

PART 1 GENERAL

1.01 DEFINITIONS

A. The Storm Water Pollution Prevention Plan (SWPPP) is defined as the improving of water quality by reducing pollutants in stormwater discharges from the construction site.

B. The Storm Water Pollution Prevention Plan shall be developed in accordance with the EPA guidebook, "Storm Water Management for Construction Activities, Developing Pollution Plans and Best Management Practices" (EPA publication number 823-R-92-005). The guidebook is a reference for information relating to the different methods of stormwater pollution prevention presented in this SWPPP.

C. Waste disposal from the construction site for construction wastes, sanitary wastes, chemicals, and dust abatement shall be conducted per the requirements of the following SWPPP sections.

1.02 SUBMITTALS

A. The CONTRACTOR shall submit an approved SWPPP to the CONSTRUCTION MANAGER.

1.03 CONTRACTOR'S RESPONSIBILITIES

A. The CONTRACTOR shall complete a Storm Water Pollution Prevention Plan (SWPPP) that complies with all state, local, and national requirements.

B. The CONTRACTOR's storage yard and construction trailer shall be located within the confines of the construction staging areas as defined in the Contract Documents. The areas designated for the CONTRACTOR's use shall contain construction materials, chemicals used during construction and their containment, and other waste materials.

C. Construction Wastes: The CONTRACTOR is responsible for proper disposal of all construction wastes. All construction wastes shall be disposed of in a proper manner via use of an on-site dumpster supplied by the CONTRACTOR. The CONTRACTOR shall provide removal services by a licensed solid waste management firm. The dumpster shall be emptied a minimum of once per week or more often if necessary. Burial of construction wastes on-site is not permitted. The CONTRACTOR shall ensure that the CONTRACTOR on-site work crews and subcontractors are trained in the proper manner of disposal for construction wastes. Disposal of solid waste from the construction site shall meet all applicable Federal, State, and local codes.

D. Sanitary Wastes: The CONTRACTOR shall hire a properly licensed sanitary waste management firm for the disposal of the sanitary waste from the construction site, including from the CONTRACTOR's trailers. Disposal of sanitary waste from the construction site shall meet all applicable Federal, State, and local codes.

E. Hazardous Wastes: All hazardous materials used for the construction shall be stored, handled, and applied per the manufacturer's printed instructions and per all applicable Federal, State, and local codes. The CONTRACTOR shall ensure that the on-site work crews and subcontractors are trained in the proper manner of disposal for hazardous wastes. The disposal of hazardous wastes from the construction site shall be the responsibility of the CONTRACTOR and shall be performed by a licensed hazardous wastes management firm.

F. The construction access to the CONTRACTOR's storage yard shall be stabilized to prevent the removal of sediment from the construction site onto the adjacent property or paved road. The stabilized access roadway shall be wide enough to handle the anticipated truck traffic to and from the construction site.

1.04 MAINTENANCE AND INSPECTION

A. Any erosion control structures and stabilization practices will be inspected by the CONSTRUCTION MANAGER on a weekly basis at a minimum and after any storm event of ½-inch or greater, unless otherwise specified. A copy of the inspection report will be provided to the CONTRACTOR.

B. All erosion control structures and stabilization practices shall be maintained in good working condition throughout the duration of the construction project.

C. Repair of the damage to any erosion control structure shall commence within 24 hours of discovery of the damage.

D. In locations where silt fences are used around catch basins, sediment trapped by the silt fence shall be removed by the CONTRACTOR when one-third of the height of the silt fence is covered by sediment.

E. All areas which undergo temporary and final stabilization with seeding or sodding shall be inspected for lack of growth and bare spots to ensure healthy growth.

F. The inspector of stormwater management controls shall be knowledgeable of the proper construction of the controls, be aware of the requirements of SWPPP, be aware of spill control practices and notification requirements, and maintain clear and accurate inspection reports. A copy of the inspection reports will be maintained and kept on-site with the latest version of the SWPPP and will be provided for the CONTRACTOR's records.

1.05 NON-STORM WATER DISCHARGES

A. Flushing of Pipelines: Pipelines shall be flushed after installation. The CONTRACTOR shall direct flushing water to a nearby storm drain system. The CONTRACTOR shall maintain siltation protection during flushing of the pipelines. If the flushing water is contaminated or if the water is suspected of having been contaminated by a regulated compound, testing may be ordered by the CONSTRUCTION MANAGER to determine contamination. Contamination is defined as having either a pH less than 5.0 or greater than 10.0, evidence of hydrocarbon contamination, or presence of free chlorine residual.

B. If testing is ordered, the CONTRACTOR shall pay for the testing. If the testing indicates the water is contaminated and this occurred due to construction activities under the control of the CONTRACTOR. The OWNER will be the sole judge of whether the flushing water is contaminated. Depending on the type of contamination, the flow shall be directed and disposed of as approved by the CONSTRUCTION MANGER or RPR.

C. Dewatering of Uncontaminated Groundwater: Water from dewatering activities during the construction of this project shall be directed to the on-site retention basin. The CONTRACTOR shall maintain siltation protection during disposal of water from dewatering activities. The CONTRACTOR shall be responsible for obtaining all necessary permits required for the dewatering activities.

D. Irrigation Water: Irrigation water shall be used for boundary landscaping and temporary stabilization seeding. The grading of the area shall be such that the irrigation water is directed to a retention pond or other storm drain system component. Irrigation of landscaped areas and berms shall be such that the irrigation water runoff does not permit washout of the topsoil.

E. Miscellaneous Washdown Water for Pavement: Washdown of structures and pavement shall occur in areas having no sign of contamination of hazardous substances, such as vehicle oil or fuel. Washdown water shall be directed to the storm drain system via proper grading of the site, particularly in the area of the washdown.

F. Equipment Testing: Water from equipment testing shall be discharged to an on-site retention pond if the water is uncontaminated. Water which contains contaminants shall be disposed through the sanitary sewer, via deep injection well located on the utility site, or by another manner depending on the type of contaminant(s). The method of disposal shall be as approved by the CONSTRUCTION MANGER or RPR prior to commencement of the equipment testing.

1.06 SPILL PREVENTION

A. Only materials used for this construction project shall be stored on-site. These materials shall be stored in quantities reasonable for use on this project.

B. Materials shall be stored in a neat and orderly fashion in their original containers. The materials shall be protected from the elements.

C. The handling and storage of all materials shall follow the Manufacturer's written instructions, the project Specifications, or applicable governmental codes; whichever is most stringent.

D. Construction material storage containers shall be disposed in a proper manner and, if possible, only after all the contents have been used.

E. The CONTRACTOR shall keep on-site all manufacturers' printed recommendations for the storage, handling, use, and disposal of construction materials.

F. The CONTRACTOR shall inspect the materials storage area on a daily basis to ensure that proper precautions are utilized for material storage.

G. The CONTRACTOR shall maintain an inventory of construction materials stored on-site. The inventory shall be kept on the site and be available for inspection by the CONSTRUCTION MANGER.

H. When transferring or unloading materials, the CONTRACTOR shall ensure that the area is protected from stormwater and that the materials transfer operation shall not cause contamination to stormwater due to runoff from the materials transfer location.

I. During adverse weather, as described in the General Conditions of the Contract Documents, and against the possibility thereof, the CONTRACTOR shall take all necessary precautions to ensure the protection of the construction materials storage area.

J. Hazardous Materials: The following additional precautions shall be followed for hazardous construction materials:

1. Hazardous materials shall be stored separately from non-hazardous material on-site.
2. Products shall remain in their original containers with the original legible product label attached to the container.
3. All products shall be used before disposal of the container.
4. Hazardous materials, including diesel fuel, must be stored in contained areas which are able to contain 150 percent of the volume of the largest container's contents. If the area is not exposed to stormwater, the volume of the containment area shall be 110 percent of the volume of the largest container's contents. Each hazardous material shall be stored in its own containment area. Under no circumstances shall hazardous materials be used or stored within 100-feet of any water supply well, unless specifically permitted by the CONSTRUCTION MANGER and governing Federal, State, or local agency.

   At a minimum, the containment area shall be constructed with dikes and lined with a material resistant to the properties of the hazardous material being contained. Before removal of any stormwater from the containment area, a representative sample of water shall be tested for contamination by the hazardous material stored in that containment area. For example, if the hazardous material is an acid, the pH of the rainwater shall be measured prior to disposal. Disposal of non-contaminated stormwater shall be directed to the nearest storm drain system component. If the stormwater is found to be contaminated, the CONTRACTOR shall follow the spill control measures for this hazardous material.

5. The CONTRACTOR shall keep the Material Safety Data Sheets of all hazardous materials at the Site.

1.07 PRODUCT SPECIFIC PRACTICES

A. Petroleum-Based Products: All on-site vehicles shall be properly maintained and checked for any leaks of fluid or petroleum-based products. If a leak is found, the vehicle shall be repaired immediately or removed from the Site. Diesel fuel shall be considered a hazardous material and shall be stored in a containment area as indicated above.

B. Acid and Base Chemicals: All acid and base chemicals are considered hazardous materials and shall be stored in containment areas as described above. Disposal of acid or base chemicals shall, under no circumstances, occur via the storm drain system, but instead through proper hazardous materials disposal procedures.

C. Paints, Thinners and Solvents: Paints, thinners, and solvents shall be stored in their original containers. Unused paints, thinners, and solvents shall not be dumped on-site or disposed through the sanitary or storm sewer system. Disposal of unused paints, thinners, and solvents shall be through proper hazardous materials disposal procedures.

D. Fertilizers and Pesticides: Fertilizers and pesticides shall be applied at the minimum rate recommended by the manufacturer. Before spraying any pesticide, a certified pesticide applicator shall receive a permit for spraying of the pesticide in a well field. Storage of fertilizers shall be transferred to sealable containers to prevent spillage and exposure to stormwater. Fertilizer shall be worked into the soil upon application in a landscaped area.

E. Concrete Trucks: The washdown of concrete trucks or the disposal of unused or unacceptable concrete from a concrete truck will be permitted on-site only if the CONTRACTOR has set aside a specific area, with dikes to prevent contact between excess concrete and washdown water or stormwater. After the solids in the area have hardened, the CONTRACTOR shall dispose of the solids in a proper manner as approved by the RPR or CONSTRUCTION MANGER.

1.08 SPILL CONTROL PRACTICES

A. In addition to the precautionary practices described above, the following practices shall be followed for spill prevention, control, cleanup, and notification:
   1. Any spills shall be cleaned up immediately.
   2. The CONTRACTOR shall notify the RPR, CONSTRUCTION MANGER, OWNER, and all applicable governmental agencies if a spill occurs.
   3. Manufacturer's printed instructions for the cleanup of a spill shall be kept on-site by the CONTRACTOR at all times. The CONTRACTOR's work crews and subcontractors shall be required to be familiar with the requirements and procedures for spill cleanup. Equipment necessary for spill cleanup, such as gloves, metal containers, mops, etc., shall be maintained on-site by the CONTRACTOR. The cleanup equipment shall be kept on-site by the CONTRACTOR during construction activities.
   4. Workers involved in the cleanup of a spill shall be properly protected by protective suits, ventilation masks, goggles, and other necessary equipment, prior to contact with the spilled material.
   5. The CONTRACTOR shall name an employee who will be on-site full-time throughout the duration of the project as the spill cleanup coordinator. The spill cleanup coordinator will be responsible for notifying the proper personnel and agencies of a spill and obtaining the proper equipment and personnel to clean up the spill. The name and phone number where the spill cleanup coordinator can be reached at all times shall be posted on the Site. The spill cleanup coordinator shall be properly trained in spill cleanup procedures.
   6. The CONTRACTOR shall maintain Material Data Safety Sheets (MSDS) on-site for all hazardous materials. The spill cleanup coordinator shall have access to the MSDSs at all times during construction. The CONTRACTOR shall provide the CONSTRUCTION MANAGER with a copy of all MSDSs.

7. After a spill is contained and cleaned up, a spill occurrence report shall be completed by the RPR and the SWPPP shall be modified to prevent a reoccurrence of a spill.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

SECTION 01 58 13

TEMPORARY PROJECT SIGNAGE

PART 1 GENERAL

1.01 SIGNBOARD

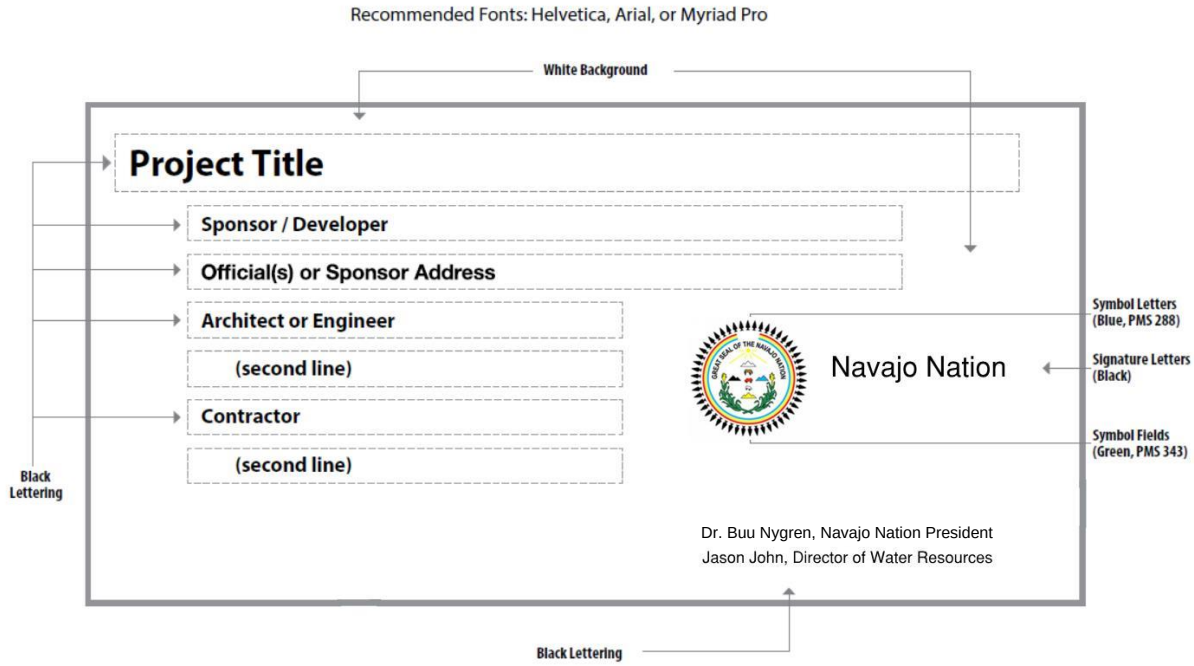
A. The Contractor shall provide one 4-foot by 8-foot multicolored signboard with a multicolored "Navajo Nation" emblem. Signboard shall be provided with 1-1/4-inch by 4-inch edging, shall be constructed of exterior grade high density overlaid plywood, and shall be mounted and located in an acceptable manner which will permit public viewing. Sign shall list the following information:

1. The final layout of the sign shall comply with the requirements of the sign details shown on Figure 01 58 13-1
2. Project Title: LeChee Water System Improvements Project

B. The Contractor shall erect the sign in accordance with the details shown on Figure 01 58 13-1 and the following specifications. The sign shall be maintained in good condition until completion of the contract, at which time the sign shall become the property of the Owner. The sign is to be painted white with lettering and emblem colors as shown. Sign support shall be 4-inch by 6-inch posts painted black, set a minimum 3 feet 6 inches in the ground. Paint shall be exterior type. The lettering shall be similar in style to that shown.

C. The Contractor and their subcontractors may erect signs for information and direction. No commercial or advertising signs will be allowed on the site of the work.

TEMPORARY CONSTRUCTION SIGN FOR PROJECTS



SIGN DIMENSIONS : 1200 mm x 2400 mm x 19 mm (approx. 4′ x 8′ x ¾″)
PLYWOOD PANEL (APA RATED A-B GRADE–EXTERIOR)

Figure 01 58 13-1

END OF SECTION

SECTION 01 61 45

AREA EXPOSURE DESIGNATIONS

PART 1 GENERAL

1.01 DESCRIPTION

A. SCOPE:

1. This section designates area exposure types for each location, room, area, or space at the site of the Work.
2. Area exposures are used to specify materials based on the corrosion environment that the material is exposed to when the materials for the component are not scheduled or otherwise identified for each specific installation (e.g., pipe, anchor bolts, pipe supports, coatings, etc.). Where materials are scheduled for specific individual components (e.g., equipment, instruments, conduit, panels, etc.), furnish materials as specified.

1.02 RELATED SECTIONS:

1. Section 01 11 80 – Environmental Conditions

1.03 DEFINITIONS

A. EXPOSURE TYPE: Included as a supplement to this Section, the Area Exposure Table designates an Exposure Type for each room or area. Each Exposure Type, listed from least to most severe corrosion potential, is defined below:

1. Indoor Exposed [IE]: Inside the water treatment plant building, heated, protected from environmental elements, may be exposed to chemicals, humidity and washdown.
2. Indoor Buried [IB]: Below slab of the water treatment plant building and outside of the building within 5.0 ft of the building structure. Covered and in contact with earth/soil.
3. Outdoor Exposed [OE]: Above grade, either outside exposed to environment and elements or inside a dry vault channel located outside. No HVAC provisions provided.
4. Outdoor Buried [OB]: Below grade, outside of the water treatment plant building at distances greater than 5.0 ft from the building structure. Covered and in contact with earth/soil.
5. Tank Submerged [TS]: Locations inside a tank or wet vault/channel, may be submerged in liquid and exposed to chemicals, minimal ventilation.

1.04 AREA EXPOSURE TABLE:

Area Exposure Types		Description	Area [1]						
			00	10	2X	30	40	50	70
IE	Indoor - Exposed	Above Grade			●				
IB	Indoor – Buried [2]	Below Grade |Under Slab			●				
OE	Outdoor - Exposed	Above Grade | Dry Vaults/Channels	●	●		●			●
OB	Outdoor - Buried	Below Grade	●	●		●	●	●	●
TS	Tank - Submerged	Inside Tanks |Wet Vaults/Channels		●		●	●		●

[1] See drawing I-00-004 for area code designations. Area 2X includes Area 20 through 27. Area 00 includes all general and undefined areas.

[2] Area Exposure Type IB extends approximately five feet into the yard outside of the building foundation.

END OF SECTION

SECTION 01 66 00

PRODUCT STORAGE AND HANDLING REQUIREMENTS

PART 1 GENERAL

1.01 DAMAGE

A. Equipment, products and materials shall be shipped, handled, stored, and installed in ways which will prevent damage to the items. Damaged items will not be permitted as part of the work except in cases of minor damage that have been satisfactorily repaired and are acceptable to the Construction Manager.

1.02 PIPE

A. Pipe and appurtenances shall be handled, stored, and installed as recommended by the manufacturer. Pipes with paint, tape coatings, linings or the like shall be stored to protect the coating or lining from physical damage or other deterioration. Pipes shipped with interior bracing shall have the bracing removed only when recommended by the pipe manufacturer.

PART 2 EQUIPMENT

2.01 PACKAGE AND MARKING:

A. All equipment shall be protected against damage from moisture, dust, handling, or other cause during transport from manufacturer's premises to site. Each item or package shall be marked with the number unique to the specification reference covering the item.

B. Stiffeners shall be used where necessary to maintain shapes and to give rigidity. Parts of equipment shall be delivered in assembled or subassembled units where possible.

2.02 IDENTIFICATION:

A. Each item of equipment and valve shall have permanently affixed to it a label or tag with its equipment or valve number designated in this contract. Marker shall be of stainless steel. Location of label will be easily visible.

2.03 SHIPPING:

A. Bearing housings, vents and other types of openings shall be wrapped or otherwise sealed to prevent contamination by grit and dirt.

B. Damage shall be corrected to conform to the requirements of the contract before the assembly is incorporated into the work. The Contractor shall bear the costs arising out of dismantling, inspection, repair and reassembly.

2.04 FACTORY APPLIED COATINGS:

A. Unless otherwise specified, each item of equipment shall be shipped to the site of the work with the manufacturer's shop applied epoxy prime coating as specified in Section 09 90 00 . The prime coating shall be applied over clean dry surfaces in accordance with the coating manufacturer's recommendations. The prime coating will serve as a base for field-applied finish coats.

2.05 STORAGE:

A. During the interval between the delivery of equipment to the site and installation, all equipment, unless otherwise specified, shall be stored in an enclosed space affording protection from weather, dust and mechanical damage and providing favorable temperature, humidity and ventilation conditions to ensure against equipment deterioration. Manufacturer's recommendations shall be adhered to in addition to these requirements.

B. Equipment and materials to be located outdoors may be stored outdoors if protected against moisture condensation. Equipment shall be stored at least 6 inches above ground. Temporary power shall be provided to energize space heaters or other heat sources for control of moisture condensation. Space heaters or other heat sources shall be energized without disturbing the sealed enclosure.

2.06 PROTECTION OF EQUIPMENT AFTER INSTALLATION:

A. After installation, all equipment shall be protected from damage from, including but not limited to, dust, abrasive particles, debris and dirt generated by the placement, chipping, sandblasting, cutting, finishing and grinding of new or existing concrete, terrazzo and metal; and from the fumes, particulate matter, and splatter from welding, brazing and painting of new or existing piping and equipment. As a minimum, vacuum cleaning, blowers with filters, protective shieldings, and other dust suppression methods will be required at all times to adequately protect all equipment. During concreting, including finishing, all equipment that may be affected by cement dust must be completely covered. During painting operations, all grease fittings and similar openings shall be covered to prevent the entry of paint. Electrical switchgear, unit substation, and motor load centers shall not be installed until after all concrete work and sandblasting in those areas have been completed and accepted and the ventilation systems installed.

END OF SECTION

SECTION 01 73 24

DESIGN REQUIREMENTS FOR
NON-STRUCTURAL COMPONENTS AND NON-BUILDING STRUCTURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Minimum structural requirements for the design, anchorage, and bracing of non-structural components such as architectural/mechanical/HVAC/electrical components, equipment, or systems, and non-building structures such as tanks.

B. The requirements of this section apply to design of the structural elements and features of equipment and to platforms/walkways that are provided with equipment or non-building structures.

C. This section applies to non-building structures and non-structural components that are permanently attached to structures as defined below and in ASCE 7.

D. Design and conform to criteria and design codes listed within this section. Engineering design is not required for attachments, anchorage, or bracing detailed on the Drawings or where the size of attachments, anchorage, or bracing is defined in specific technical specification sections.

E. The following non-structural components are exempt from seismic design loading requirements of this section.
   1. Furniture (except permanent floor supported storage cabinets over 6 ft tall).
   2. Temporary or movable equipment.
   3. Architectural components in Seismic Design Category B other than parapets supported by bearing walls or shear walls provided that the component importance factor, I_p, is equal to 1.0.
   4. Mechanical and electrical components in Seismic Design Category B.
   5. Mechanical and electrical components in Seismic Design Category C provided that the component importance factor, I_p, is equal to 1.0.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related section. Additional related sections may apply that are not specifically listed below.
   1. Section 05 05 20 Anchor Bolts
   2. Section 05 50 00 Metal Fabrications

1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
Aluminum Design Manual	Aluminum Association, Aluminum Design Manual with Specifications and Guidelines for Aluminum Structures
AAMA	American Architectural Manufacturer's Association
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures
ACI 350.3	Seismic Design of Liquid-Containing Concrete Structures
AISC 341	Seismic Provisions for Structural Steel Buildings
ACI 360	Specification for Structural Steel Buildings
ASCE 7	Minimum Design Loads for Buildings and Other Structures
ASTM C635	Manufacture, Performance and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
ASTM C636	Installation for Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
AWS D1.1	Structural Welding Code – Steel
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.6	Structural Welding Code – Stainless Steel
AWS D1.8	Structural Welding Code – Seismic Supplement
ADOSH	Arizona Division of Occupational Safety and Health Administration
IBC	International Building Code with local amendments
NFPA-13	Installation of Sprinkler Systems
OSHA	U.S. Dept. of Labor, Occupational Safety and Health Administration
SMACNA	Seismic Restraint Manual Guidelines for Mechanical Systems

1.04 DEFINITIONS

A. Structure: The structural elements of a building that resist gravity, seismic, wind, and other types of loads. Structural components include columns, posts, beams, girders, joists, bracing, floor or roof sheathing, slabs or decking, load-bearing walls, and foundations.

B. Non-structural Components: Non-structural portions of a building include every part of the building and all its contents, except the structural portions, that carry gravity loads and that may also be required to resist effects of wind, snow, impact, temperature and seismic loads. Non-structural components include, but are not limited to, ceilings, partitions, windows, equipment, piping, ductwork, furnishings, lights, etc.

C. Non-building Structures: Self-supporting structures that carry gravity loads and that may also be required to resist the effects of wind, snow, impact, temperature and seismic loads. Non-building structures include, but are not limited to, pipe racks, storage racks, stacks, tanks, vessels and structural towers that support tanks and vessels.

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for requested deviations to specification requirements, with the submittal is sufficient cause for rejection of the entire submittal with no further consideration.
4. For structural elements of non-structural components and non-building structures required to be designed per this section, provide Drawings and design calculations stamped by a Arizona licensed professional engineer qualified to perform structural engineering.
5. List of non-structural components and non-building structures requiring wind and seismic design and anchorage.
6. Shop drawings showing details of complete wind and seismic bracing and anchorage attachment assemblies including connection hardware, and embedment into concrete.
7. Shop drawings showing plans, elevations, sections and details of equipment support structures and non-building structures, including anchor bolts, structural members, platforms, stairs, ladders, and related attachments.
8. Identify interface points with supporting structures or foundations, as well as size, location, and grip of required attachments and anchor bolts. Clearly indicate who will be providing each type of attachment/anchor bolt. Equipment vendor shall design anchor bolts, including embedment into concrete, and submit stamped calculations.
9. Calculations for supports, bracing, and attachments shall clearly indicate design criteria applied. Coordinate concrete embedment calculations with thickness and strength of concrete members. Submit a tabulation of the magnitude of unfactored (service level) equipment loads at each support point, broken down by type of loading (dead, live, wind, seismic, etc.). Indicate impact factors applied to these loads in design calculations.

1.06 QUALITY ASSURANCE

A. Quality Control By Owner:
   1. Special Inspection of non-structural components and non-building structures, and their anchorages shall be performed by the Special Inspector under contract with the Owner and in conformance with IBC Chapter 17. Special Inspector(s) and laboratory shall be acceptable to the Owner in their sole discretion. Special Inspection is in addition to, but not replacing, other inspections and quality control requirements. Where sampling and testing required conforms to Special Inspection standards, such sampling and testing need not be duplicated.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide materials in conformance with information shown on the Drawings and in other technical specification sections. See individual component and equipment specifications for additional requirements.

2.02 DESIGN CRITERIA

A. Design Codes

Design	Code
Buildings/Structures:	International Building Code 2018 and ASCE 7-16
Reinforced concrete:	ACI 350-06 and ACI 350.3-06 for Concrete Liquid Containing Structures, ACI 318-14 for all other reinforced concrete
Structural steel:	AISC 360-16
Aluminum:	Aluminum Design Manual, Latest Edition
Welding:	AWS Welding Codes, Latest Edition
Occupational health and safety requirements:	OSHA and ADOSH

Note: When conflicting requirements occur, the most stringent requirements will govern the design.

B. Design Loads

1. Design non-structural components and non-building structures for the following minimum loads: (Do not apply wind and snow loads to non-structural components and non-building structures that are located inside buildings.)
2. Dead Loads:
   a. Add an additional allowance for piping and conduit when supported and hung from the underside of equipment and platforms.
   b. Typical allowance for piping and conduit: 20 psf
3. Uniform Live Loads:

Elevated grating floors:	100 psf
Columns:	No column live load reduction allowed
Exitways, stairs and landings:	100 psf
Equipment platforms, walkways/catwalks (other than exitways):	60 psf

4. Snow Loads:

Code:	IBC 2018 & ASCE 7
Risk Category:	IV (Water Treatment facilities are Risk Category IV)
Ground Snow Load (p_g):	30 psf
Exposure Factor (C_e):	C
Thermal Factor (C_t):	1.0
Importance Factor (I_s):	1.2
Flat Roof Snow Load (p_f):	22.7 psf
Drifting:	Per ASCE 7

5. Wind Loads:

Code:	IBC 2018 & ASCE 7-16
Risk Category:	IV (Water Treatment Facilities are Risk Category IV)
Basic Wind Speed (Ultimate, 3-second gust) for Risk Category Shown Above:	115 mph
Exposure:	C
Topographic Factor (K_{zt})	1.0

Note:

1. *Design exterior non-strutural components and non-building structures, unless located in a pit or basin, to withstand design wind loads without consideration of shielding effects by other structures.*

6. Seismic Loads:

Code:	IBC 2018 & ASCE 7-16
Risk Category:	IV (Water Treatment Facilities are Risk Category IV)
0.2 Sec. Mapped Spectral Response, S_S:	0.31 g
1.0 Sec. Mapped Spectral Response, S_1:	0.096 g
Site Class:	B – Default
0.2 Sec. Design Spectral Response, S_{DS}:	0.186 g
1.0 Sec. Design Spectral Response, S_{D1}:	0.051 g
Importance Factor (I_e):	1.5
Component Importance Factor (I_p):	1.0, except I_p=1.5 for components identified in Section 13.1.3 of ASCE 7
Seismic Design Category	C

Notes:

1. *Calculate seismic loads on the basis of governing building code. Include equipment operating loads in structure dead load.*
2. *Check individual members for seismic and full member live load acting simultaneously, except that flooded equipment loads (infrequent occurrence) need not be combined with seismic loads. Combine equipment operating loads with seismic loads.*

7. Impact Loads:
   a. Consider impact loads in design of support systems.
   b. Use the following impact load factors unless recommendations of the equipment manufacturer will cause a more severe load case:

Rotating machinery:	20% of moving load
Reciprocating machinery:	50% of moving load
Hangers supporting floors and platforms:	33% of live and dead load

8. Temperature:
   a. Include effects of temperature in design where non-structural components and non-building structures are exposed to differential climatic conditions. See climatic conditions below for temperature extremes.

C. Load Combinations
   1. Design non-structural components and non-building structures to withstand load combinations as specified in the governing building code. Where the exclusion of live load or impact load would cause a more severe load condition for the member under investigation, ignore the load when evaluating that member.

D. Design Considerations
   1. Design non-structural components and non-building structures for the following conditions:
   2. Climatic Conditions:

Maximum design temperature:	90	degrees Fahrenheit
Minimum design temperature:	15	degrees Fahrenheit

   3. Foundations:
      a. Extend foundations supporting non-structural components and non-building structures below the frost line, or support on non-frost susceptible structural fill down to the frost line.

Frost line for foundations:	12 inches

Note: Consult project geotechnical report for allowable soil bearing recommendations at location of structure.

E. Column Base Fixity
   1. Design column bases as pinned connections. No moments shall be assumed to be transferred to foundations.
   2. Where significant shear loads (greater than 5,000 lb. per anchor bolt) are transferred at column base plates, provide a shear key designed to transfer shear load.

F. Deflection
   1. Maximum beam deflection as a fraction of span for walkways and platforms: L/240 for total load and L/360 for live load.
   2. Maximum total load deflection for equipment support: L/450.

PART 3 EXECUTION

3.01 GENERAL

A. Make attachments and braces in such a manner that component force is transferred to the lateral force-resisting system of the structure. Base attachment requirements and size and number of braces per calculations submitted by Contractor.

B. Anchorage of equipment is specified to be made by cast-in anchor bolts in concrete elements unless specifically noted otherwise on the Drawings or other specification sections. Contractor is responsible for remedial work or strengthening (of concrete elements because of superimposed seismic loading) if anchor bolts are improperly installed or omitted due to lack of submittal review or improper placement for any reason, at no additional cost to Owner.

C. Provide anchor bolts in accordance with Section 05 05 20. Base size of anchor bolts and embedment on submitted calculations.

D. Submit details of and calculations for anchorages prior to placement of concrete or erection of other structural supporting members. Submittals received after structural supports are in place will be rejected if proposed anchorage method would create an overstressed condition of the supporting member. Contractor is responsible for revisions to anchorages and/or strengthening of structural support so that there is no overstress condition, at no additional cost to Owner.

END OF SECTION

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SECTION 01 73 29

CUTTING AND PATCHING

PART 1 GENERAL

1.01 STRUCTURES

A. The Contractor shall take all precautions necessary to protect the integrity and usefulness of all existing plant facilities. If necessary, the Contractor may, with the approval of the Owner, remove such existing structures, including curbs, gutters, pipelines and utility poles as may be necessary for the performance of the work, and shall rebuild the structures thus removed in as good a condition as found with the requirements specified. He shall also repair existing structures which may be damaged as a result of the work under this contract.

1.02 ROADS AND STREETS

A. Unless otherwise specified, roads and streets in which the surface is removed, broken, or damaged, or in which the ground has caved or settled during the work under this contract, shall be resurfaced and brought to the original grade and section. Roadways used by the Contractor shall be cleaned and repaired. Before resurfacing material is placed, edges of pavements shall be trimmed back far enough to provide clean, solid, vertical faces, and shall be free of loose material. All paved surfaces shall be cut with a pavement saw. Rough cuts are not allowed. Repair work shall conform to the paving specifications.

1.03 CULTIVATED AREAS AND OTHER SURFACE IMPROVEMENTS

A. Cultivated or planted areas and other surface improvements which are damaged by actions of the Contractor shall be restored as nearly as possible to their original condition. Restoration shall take place within 1 week or sooner as directed by the Construction Manager.

B. Existing guard posts, barricades, and fences shall be protected and replaced if damaged.

1.04 PROTECTION OF EXISTING INSTALLATIONS

A. The Contractor shall protect all existing operating facilities and structures from damages. However, if damage occurs, the Contractor shall immediately correct or replace existing equipment, controls, systems, structures, or facilities which are damaged in any way as a result of his operations.

END OF SECTION

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SECTION 01 74 10

CLEANING AND DISINFECTION OF POTABLE WATER FACILITIES

PART 1 GENERAL

1.01 SUMMARY

A. Clean and disinfect treatment facilities, structures, piping, equipment, and appurtenances in accordance with local regulations and referenced AWWA standards.

B. Obtain permits for discharging cleaning and disinfection water, and treat such water as required by permit.

C. All chemicals used for cleaning and disinfection shall comply with NSF/ANSI/CAN 60 – Drinking Water Chemicals – Health Effects.

1.02 REFERENCES

A. This Section contains references to the following documents. Those documents are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section prevail.

B. Unless otherwise specified, references to documents mean the documents are in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents mean the replacement documents issued or otherwise identified by that organization, or if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, is discontinued or replaced.

Reference	Title
AWWA/ANSI C651	Disinfecting Water Mains
AWWA/ANSI C652	Disinfection of Water-Storage Facilities
AWWA/ANSI C653	Disinfection of Water Treatment Plants
AWWA/ANSI C654	Field Dechlorination
NSF/ANSI/CAN 60	Drinking Water Treatment Chemicals – Health Effects
NSF/ANSI/CAN 61	Drinking Water System Components – Health Effects

1.03 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:

1. Treatment facilities, structures, piping, equipment, and appurtenances: everything in contact with the water and everything to the top of a water-containing structure, whether immersed or not, including the underside of a covering slab or walkway. Does not include the top (horizontal) surface of walls or surrounding walkway.

2. For other terms see AWWA C653.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. See Section 01 12 16 Work Sequence.
   2. Schedule major disinfection operations to allow witnessing by the Owner and Construction Manager.

B. Meetings:
   1. Organize and lead a minimum of one meeting with Owner and Construction Manager at least two weeks prior to each major cleaning and disinfection operation to review Cleaning and Disinfection Plan, Disinfection Safety Plan, and schedule of activities

1.05 SUBMITTALS

A. Action Submittals
   1. Procedures: Section 01 33 00 Submittals
   2. A Cleaning and Disinfection Plan and schedule, by each facility or location, including sequencing of the work, permits and approvals required, water conveyance, control and disposal; details of chemicals to be used; ventilation; methods for disinfectant monitoring and bacteriological testing.
   3. Resume of Disinfection Technician responsible for planning and managing the activities.
   4. Qualifications and Certifications of Drinking Water Laboratory.

B. Information Submittals
   1. Procedures: Section 01 33 00 Submittals
   2. Disinfection Safety Plan for storage and handling of disinfecting and dechlorination chemicals, including Engineering Controls, ventilation, and the use of Personal Protective Equipment.

C. Closeout Submittals
   1. Procedures: Section 01 33 00 Submittals
   2. Field test report describing deviations from planned setup and activities, issues encountered and subsequent resolution, and results of all compliance testing Obtain sign-off from Owner's witness.
   3. Record of Compliance in accordance with referenced Standard(s) evidencing successful disinfection.

1.06 QUALITY ASURANCE

A. Qualifications
   1. Disinfection Technician: Responsible for planning and managing disinfection activities for a minimum of five projects of similar size and scope completed within the past five years.
   2. Testing Laboratory: Certified by State of Arizona or EPA for analyzing drinking water for compliance monitoring.

B. Perform cleaning and disinfection operations in the presence of the Owner and Construction Manager.

PART 2 PRODUCTS

2.01 EQUIPMENT AND MATERIALS

A. Design temporary valves, bulkheads, and other water delivery, control, and disposal equipment. Use only materials in contact with the water that comply with NSF/ANSI/CAN 61 standard.

B. Use only disinfectant chemicals that are certified to NSF/ANSI/CAN 60 standard. Chlorine for disinfection may be liquid chlorine, sodium hypochlorite solution, or calcium hypochlorite granules or tablets.

1. Liquid chlorine shall be in accordance with ANSI/AWWA B301 - Liquid Chlorine.
2. Sodium and calcium hypochlorite shall be in accordance with ANSI/AWWA B300 - Hypochlorite.

C. Use only dechlorination agents that are certified to NSF/ANSI/CAN 60 standard. Dechlorination agents may be sodium bisulfite, sodium sulfate, calcium thiosulfate, or ascorbic acid.

PART 3 EXECUTION

3.01 GENERAL

A. Potable water for cleaning and disinfecting will be furnished by the Contractor.

B. Clean all hydraulic structures, piping, equipment, and appurtenances in accordance with the relevant standard – AWWA/ANSI C651, C652 and/or C653.

C. Disinfect hydraulic structures, piping, equipment, and appurtenances downstream of Chlorine injection point immediately after the GAC process in accordance with the relevant standard AWWA/ANSI C651, C652 and/or C653.

D. Disinfect facilities as late as possible during the Contract Time to maximize the degree of sterility of the facilities at the time the Work is accepted by the Owner.

E. Convey cleaning and disinfecting water to the point of discharge as approved by the Owner and treat (dechlorination and solids removal) in compliance with Permits, Approvals, and all applicable regulations.

3.02 CONNECTIONS TO EXISTING SYSTEM

A. Disinfect connections to existing potable water systems in accordance with AWWA/ANSI C651.

3.03 BACTERIOLOGICAL SAMPLING AND TESTING

A. Provide compliance sampling and testing in compliance with the referenced standards by a certified Drinking Water Laboratory.

3.04 RE-DISINFECTION AND RETESTING

A. Re-disinfect and retest a given tank or piping segment where testing shows the presence of total coliform bacteria or results are otherwise not satisfactory. Provide re-disinfection, sampling and retesting at no additional cost to the Owner until test results are satisfactory.

B. If a disinfected facility is not immediately returned to service, the Owner at their sole discretion, will determine if the sterility or water quality may have been adversely affected due to the delay and re-disinfection is warranted. Re-disinfect and retest the facility, if required, at the Contractor's expense if Contractor caused the delay or at the Owner's expense if Owner caused the delay.

3.05 VENTILATION

A. Provide ventilation equipment to supplement existing ventilation system(s) as required for safe operation.

END OF SECTION

SECTION 01 74 23

FINAL CLEANING

PART 1 GENERAL

1.01 GENERAL

A. At the completion of work and immediately prior to final inspection, cleaning of the entire project shall be accomplished according to the following provisions:

1. The Contractor shall thoroughly clean, sweep, wash, and polish all work and equipment provided under the Contract, including finishes. The cleaning shall leave the structures and site in a complete and finished condition to the satisfaction of the Construction Manager.
2. All subcontractors shall similarly perform, at the same time, an equivalent thorough cleaning of all work and equipment provided under their Contracts.
3. The Contractor shall remove all temporary structures and all debris, including all dirt, sand, gravel, rubbish and waste material.
4. Should the Contractor not remove rubbish or debris or not clean the buildings and site as specified, the Owner reserves the right to have the cleaning done at the expense of the Contractor.
5. Only experienced workers, or professional cleaners, shall be employed for final cleaning.
6. Only cleaning materials recommended by the manufacturer of surface to be cleaned shall be used.
7. Cleaning materials shall be used only on surfaces recommended by the cleaning material manufacturers.
8. In preparation for substantial completion or occupancy, a final inspection of sight-exposed interior and exterior surfaces, and of concealed spaces, shall be conducted.
9. Grease, dust, dirt, stains, labels, fingerprints, and other foreign materials shall be removed from sight-exposed interior and exterior finished surfaces. Polish surfaces so designated to shine finish.
10. Marred surfaces shall be repaired, patched, and touched up to specified finish, to match adjacent surfaces.
11. Air-handling filters shall be cleaned if units were operated during construction.
12. Ducts, blowers, and coils shall be cleaned, if air-handling units were operated without filters during construction.
13. All interior spaces shall be vacuum cleaned, including inside cabinets.
14. Materials shall be handled in a controlled manner with as few handlings as possible. Do not drop or throw materials from heights

1.02 OWNER OCCUPANCY

A. As a condition precedent to final acceptance or release of a structure, space or process unit for use by the Owner, the Contractor and all subcontractors shall thoroughly clean all floors, walls, woodwork, and windows to leave same in first-class condition.

B. All building roof gutters, downspouts, pits and sumps shall be cleared of silt, sand, debris, and construction materials. Ductwork air intakes and exhaust grilles shall be

inspected and cleared of dust and extraneous material, and all grounds shall be cleared of all debris. Finished floors shall be thoroughly cleaned, sealed, and given a final coat of wax. The Contractor shall also remove all paint from and clean all window glass and all plumbing fixtures. Carpeted areas shall be thoroughly vacuumed, and steam cleaned. Blinds, all furniture, and cabinets shall be dusted.

1.03 POST-CONSTRUCTION REPAIRS

A. The Contractor shall make such minor repairs and alterations as may be necessary to make any building or structure ready for occupancy including touch-up paint, refit windows, doors, and cabinets. The Contractor shall replace all broken and scratched glass with material which complies with the Contract Documents. This section shall not apply after or to the extent that the Owner has taken possession of a building on which the Contractor has performed work.

1.04 SITE CLEANUP

A. For all roadway work, the Contractor shall conform the work to acceptable line and grade, as determined by the RPR or Construction Manager. In addition, the Contractor shall have the sidewalks and streets affected by the work swept by a street or sidewalk cleaner as determined by the RPR or Construction Manager. Other surfaces of the grounds shall be rake cleaned. The Owner will not authorize final payment until the Contractor has removed all rubble and debris from the street and adjoining work areas, including all temporary storage and parking areas used by the Contractor.

B. For pipelines, storm sewers, catch basins, manholes, and all building floor drains, prior to their activation or at the end of the project, the Contractor shall thoroughly clean all of the new pipes by flushing with water for fluid lines, or compressed air for gas lines. Debris cleaned from the lines shall be removed from the lowest access point.

C. All temporary utility drops, fencing, and water supply outlets shall be removed.

D. All plant gate identification signs, barricades, tools, rubbish collection receptacles and other such items shall be removed by the Contractor.

E. All remaining earthen stockpiles of excess excavated material shall be graded to provide gentle slopes to prevent erosion as directed by the RPR or Construction Manager.

END OF SECTION

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SCOPE

A. Operation and maintenance (O&M) instructions shall be provided in accordance with this section and as required in the technical sections of this project manual. O&M information shall be provided for each maintainable piece of equipment, equipment assembly or subassembly, and material provided or modified under this contract.

B. O&M instructions must be submitted and accepted before on-site training may start.

1.02 TYPES OF INFORMATION REQUIRED

A. General:
   1. O&M information shall contain the names, addresses, and telephone numbers of the manufacturer, the nearest representative of the manufacturer, and the nearest supplier of the manufacturer's equipment and parts. In addition, one or more of the following items of information shall be provided as applicable.

B. Operating Instructions:
   1. Specific instructions, procedures, and illustrations shall be provided for the following phases of operations:
      a. Safety Precautions: List personnel hazards for equipment and list safety precautions for all operating conditions.
      b. Operator Prestart: Provide requirements to set up and prepare each system for use.
      c. Start-Up, Shutdown, And Postshutdown Procedures: Provide a control sequence for each of these operations.
      d. Normal Operations: Provide control diagrams with data to explain operation and control of systems and specific equipment.
      e. Emergency Operations: Provide emergency procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include emergency shutdown instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance on emergency operations of all utility systems including valve locations and portions of systems controlled.
      f. Operator Service Requirements: Provide instructions for services to be performed by the operator such as lubrication, adjustments, and inspection.
      g. Environmental Conditions: Provide a list of environmental conditions (temperature, humidity, and other relevant data) which are best suited for each product or piece of equipment and describe conditions under which equipment should not be allowed to run.

C. Preventive Maintenance:
   1. The following information shall be provided for preventive and scheduled maintenance to minimize corrective maintenance and repair:
      a. Lubrication Data: Provide lubrication data, other than instructions for lubrication in accordance with paragraph 1.02 Operator Service Requirements.
         1) A table showing recommended lubricants for specific temperature ranges and applications;
         2) Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities; and
         3) A lubrication schedule showing service interval frequency.
      b. Preventive Maintenance Plan And Schedule: Provide manufacturer's schedule for routine preventive maintenance, inspections, tests, and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair. Provide manufacturer's projection of preventive maintenance man-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft.

D. Corrective Maintenance:
   1. Manufacturer's recommendations shall be provided on procedures and instructions for correcting problems and making repairs.
      a. Troubleshooting Guides And Diagnostic Techniques: Provide step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.
      b. Wiring Diagrams And Control Diagrams: Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job-specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type identically to actual installation numbering.
      c. Maintenance And Repair Procedures: Provide instructions and list tools required to restore product or equipment to proper condition or operating standards.
      d. Removal And Replacement Instructions: Provide step-by-step procedures and list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings, and adjustments required. Instructions shall include a combination of test and illustrations.
      e. Spare Parts And Supply Lists: Provide lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonably delays. Special consideration is required for facilities at remote locations. List spare parts and supplies that have a long lead time to obtain.
      f. Corrective Maintenance Manhours: Provide manufacturer's projection of corrective maintenance man-hours including craft requirements by type of craft. Corrective maintenance that requires participation of the equipment manufacturer shall be identified and tabulated separately.

E. Appendices:

1. The following information shall be provided; include information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment.

    a. Parts Identification: Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number which will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies.

    b. Warranty Information: List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or contract documents to keep warranties in force.

    c. Personnel Training Requirements: Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly.

    d. Testing Equipment And Special Tool Information: Provide information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

1.03 TRANSMITTAL PROCEDURE

A. Unless otherwise specified, O&M manuals, information, and data shall be transmitted in accordance with Section 01 33 00 accompanied by Transmittal Form 01 78 23-A and Equipment Record Forms 01 78 23-B and/or 01 78 23-C, as appropriate, all as specified in Section 01 99 90. The transmittal form shall be used as a checklist to ensure the manual is complete. Only complete sets of O&M instructions will be reviewed for acceptance.

B. Three hard copies and 1 electronic pdf copy of the specified O&M information shall be provided. For ease of identification, each manufacturer's brochure and manual shall be appropriately labeled with the equipment name and equipment number as it appears in the project manual. The information shall be organized in the binders in numerical order by the equipment numbers assigned in the project manual. The binders shall be provided with a table of contents and tab sheets to permit easy location of desired information. Binders shall be 3-ring, of uniform color (preferably white) with plastic view covers for cover page and spine inserts. The binders shall be sized adequately to accommodate the appropriate manual. The outside cover page insert, and spine insert shall include the equipment location, project number, all applicable equipment ID numbers, description, supplier name and purchase agreement number. The inside cover page shall include all applicable equipment ID numbers, description, location, “Purchased From” (supplier name), “purchased by” (purchaser name), suppliers contact information, and purchase agreement number. All manuals shall also have a uniform tabbed Table of Contents.

C. If manufacturers' standard brochures and manuals are used to describe O&M procedures, such brochures and manuals shall be modified to reflect only the model or series of equipment used on this project. Extraneous material shall be crossed out neatly or otherwise annotated or eliminated.

1.04 PAYMENT

A. Acceptable O&M information for the project must be delivered to the Construction Manager prior to the project being 65 percent complete. Progress payments for work in excess of 65 percent completion will not be made until the specified acceptable O&M information has been delivered to the Construction Manager.

1.05 FIELD CHANGES

A. Following the acceptable installation and operation of an equipment item, the item's instructions and procedures shall be modified and supplemented by the Contractor to reflect any field changes or information requiring field data.

END OF SECTION

SECTION 01 78 39

PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.01 DRAWINGS

A. Record drawings refer to those documents maintained and annotated by the Contractor during construction and are defined as
   1. a neatly and legibly marked set of contract drawings showing the final location of piping, equipment, electrical conduits, outlet boxes and cables;
   2. additional documents such as schedules, lists, drawings, and electrical and instrumentation diagrams included in the specifications; and
   3. Contractor layout and installation drawings.

B. Unless otherwise specified, record drawings shall be full size and maintained in a clean, dry, and legible condition. Record documents shall not be used for construction purposes and shall be available for review by the RPR and Construction Manager during normal working hours at the Contractor's field office. At the completion of the work, prior to final payment, all record drawings shall be submitted to the Construction Manager.

C. Marking of the drawings shall be kept current and shall be done at the time the material and equipment are installed. Annotations to the record documents shall be made with an erasable colored pencil conforming to the following color code:
   1. Additions - Red
   2. Deletions - Green
   3. Comments - Blue
   4. Dimensions - Graphite*

**Legibly mark to record actual depths, horizontal and vertical location of underground raceways, cables, and appurtenances referenced to permanent surface improvements.*

END OF SECTION

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SECTION 01 79 00

DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.01 DESCRIPTION

A. This section contains requirements for training the Owner's personnel, by persons retained by the Contractor specifically for the purpose, in the proper operation and maintenance of the equipment and systems installed under this contract.

1.02 QUALITY ASSURANCE

A. Where required by the detailed specifications, the Contractor shall provide on-the-job training of the Navajo Tribal Utility Athority's (NTUA) personnel. The training sessions shall be conducted by qualified, experienced, factory-trained representatives of the various equipment manufacturers. Training shall include instruction in both operation and maintenance of the subject equipment.

1.03 SUBMITTALS

A. The following information shall be submitted to the Construction Manager in accordance with the provisions of Section 01 33 00. The material shall be reviewed and accepted by the Construction Manager as a condition precedent to receiving progress payments in excess of 50 percent of the contract amount and not less than 3 weeks prior to the provision of training.
   1. Lessons plans for each training session to be conducted by the manufacturer's representatives. In addition, training manuals, handouts, visual aids, and other reference materials shall be included.
   2. Subject of each training session, identity and qualifications of individuals to be conducting the training, and tentative date and time of each training session.

PART 2 PRODUCTS

2.01 GENERAL

A. Where specified, the Contractor shall conduct training sessions for the NTUA's personnel to instruct the staff on the proper operation, care, and maintenance of the equipment and systems installed under this contract. Training shall take place at the site of the work and under the conditions specified in the following paragraphs. Approved operation and maintenance manuals shall be available at least 30 days prior to the date scheduled for the individual training session.

2.02 LOCATION

A. Training sessions shall take place at the site of the work.

2.03 LESSON PLANS

A. Formal written lesson plans shall be prepared for each training session. Lesson plans shall contain an outline of the material to be presented along with a description of visual

aids to be utilized during the session. Each plan shall contain a time allocation for each subject.

B. One complete set of originals of the lesson plans, training manuals, handouts, visual aids, and reference material shall be the property of the Owner and shall be suitably bound for proper organization and easy reproduction. The Contractor shall furnish ten copies of necessary training manuals, handouts, visual aids and reference materials at least 1 week prior to each training session.

2.04 FORMAT AND CONTENT

A. Each training session shall be comprised of time spent both in the classroom and at the specific location of the subject equipment or system. As a minimum, training session shall cover the following subjects for each item of equipment or system:
   1. Familiarization
      a. Review catalog, parts lists, drawings, etc., which have been previously provided for the plant files and operation and maintenance manuals.
      b. Check out the installation of the specific equipment items.
      c. Demonstrate the unit and indicate how all parts of the specifications are met.
      d. Answer questions.
   2. Safety
      a. Using material previously provided, review safety references.
      b. Discuss proper precautions around equipment.
   3. Operation
      a. Using material previously provided, review reference literature.
      b. Explain all modes of operation (including emergency).
      c. Check out NTUA's personnel on proper use of the equipment.
   4. Preventive Maintenance
      a. Using material previously provided, review preventive maintenance (PM) lists including:
         1) Reference material.
         2) Daily, weekly, monthly, quarterly, semiannual, and annual jobs.
      b. Show how to perform PM jobs.
      c. Show NTUA's personnel what to look for as indicators of equipment problems.
   5. Corrective Maintenance
      a. List possible problems.
      b. Discuss repairs--point out special problems.
      c. Open up equipment and demonstrate procedures, where practical.
   6. Parts
      a. Show how to use previously provided parts list and order parts.
      b. Check over spare parts on hand. Make recommendations regarding additional parts that should be available.
   7. Local Representatives
      a. Where to order parts: name, address, telephone.
      b. Service problems:

1) Who to call.
2) How to get emergency help.

8. Operation and Maintenance Manuals
   a. Review any other material submitted.
   b. Update material, as required.

2.05 VIDEO RECORDING:

A. The Owner may retain the services of a commercial video taping service to record each training session. After taping, the material will be edited and supplemented with professionally produced graphics to provide a permanent record. The Contractor shall advise all manufacturers providing training sessions that the material may be video taped and shall make available to the Owner's video taping contractor such utility services and accommodation as may be required to facilitate the production of the video tape record.

PART 3 EXECUTION

3.01 SUMMARY

A. Training shall be conducted in conjunction with the operational testing and commissioning periods. Classes shall be scheduled such that classroom sessions are interspersed with field instruction in logical sequence. The Contractor shall arrange to have the training conducted on consecutive days, with no more than 6 hours of classes scheduled for any one day. Concurrent classes shall not be allowed. Training shall be certified on Form 43 05 11-B specified in Section 01 99 90.

B. Acceptable operation and maintenance manuals for the specific equipment shall be provided to the Owner prior to the start of any training. Video taping shall take place concurrently with all training sessions.

C. The following services shall be provided for each item of equipment or system as required in individual specification sections. Additional services shall be provided, where specifically required in individual specification sections.
   1. As a minimum classroom equipment training for operations personnel will include:
      a. Using slides and drawings, discuss the equipment's specific location in the plant and an operational overview.
      b. Purpose and plant function of the equipment.
      c. A working knowledge of the operating theory of the equipment.
      d. Start-up, shutdown, normal operation, and emergency operating procedures, including a discussion on system integration and electrical interlocks, if any.
      e. Identify and discuss safety items and procedures.
      f. Routine preventative maintenance, including specific details on lubrication and maintenance of corrosion protection of the equipment and ancillary components.
      g. Operator detection, without test instruments, of specific equipment trouble symptoms.
      h. Required equipment exercise procedures and intervals.

i. Routine disassembly and assembly of equipment if applicable (as judged by the Owner on a case-by-case basis) for purposes such as operator inspection of equipment.

2. As a minimum, hands-on equipment training for operations personnel will include:
   a. Identify location of equipment and review the purpose.
   b. Identifying piping and flow options.
   c. Identifying valves and their purpose.
   d. Identifying instrumentation:
      1) Location of primary element.
      2) Location of instrument readout.
      3) Discuss purpose, basic operation, and information interpretation.
   e. Discuss, demonstrate, and perform standard operating procedures and round checks.
   f. Discuss and perform the preventative maintenance activities.
   g. Discuss and perform start-up and shutdown procedures.
   h. Perform the required equipment exercise procedures.
   i. Perform routine disassembly and assembly of equipment if applicable.
   j. Identify and review safety items and perform safety procedures, if feasible.
3. Classroom equipment training for the maintenance and repair personnel will include:
   a. Theory of operation.
   b. Description and function of equipment.
   c. Start-up and shutdown procedures.
   d. Normal and major repair procedures.
   e. Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the "pass" and "no pass" test instrument readings.
   f. Routine and long-term calibration procedures.
   g. Safety procedures.
   h. Preventative maintenance such as lubrication; normal maintenance such as belt, seal, and bearing replacement; and up to major repairs such as replacement of major equipment part(s) with the use of special tools, bridge cranes, welding jigs, etc.
4. Hands-on equipment training for maintenance and repair personnel shall include:
   a. Locate and identify equipment components.
   b. Review the equipment function and theory of operation.
   c. Review normal repair procedures.
   d. Perform start-up and shutdown procedures.
   e. Review and perform the safety procedures.
   f. Perform Owner approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.

END OF SECTION

SECTION 01 91 00

COMMISSIONING, TESTING AND START-UP

PART 1 GENERAL

1.01 SUMMARY

A. This Section establishes the Contractor's responsibilities for developing and conducting the complete commissioning, including testing and startup, of all equipment, systems, and facilities (new or existing) which are defined within the Contract Documents. This effort and the associated experience requirements are significant and critical to a safe and successful startup that meets the project schedule requirements.

B. This Section provides the overarching guidelines for commissioning but does not supersede specific testing requirements found elsewhere in the Contract Documents. Where there is any discrepancy, Contractor shall assume the more stringent requirements control unless confirmed otherwise by the Engineer. Refer to Division 26 and Division 40 for specific execution requirements related to electrical and instrumentation components and systems. For pre-commissioning activities, refer to other technical specifications, including Division 03 for requirements for testing of concrete hydraulic structures and Section 40 05 01 for testing requirements of hydraulic structures and piping.

C. All commissioning activities must be coordinated early in the project to minimize interference with the operation of the existing facility, or delays to the project schedule; see Section 01 12 16 for project work sequence and constraints. Unless otherwise specified, or agreed to in advance by the Engineer, Owner and Construction Manager, no commissioning activities will be scheduled to take place on a weekend or holiday recognized by the Owner.

D. This Section contains specific references to the following related specification sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 11 00 Summary of Work
   2. Section 01 12 16 Work Sequence
   3. Section 01 32 16 Construction Progress Schedule
   4. Section 01 33 00 Submittal Procedures
   5. Section 01 45 23 Testing and Inspection Services

E. The Contractor shall provide an experienced Commissioning Manager who will be responsible for overseeing, organizing, administering, recording, and documenting all aspects of the commissioning efforts.

F. A representative or representatives of the equipment manufacturer(s) shall participate in the commissioning phases per the requirements of the Specifications.

1. Commissioning Overview: The sequence of the commissioning shall proceed as follows. Variations to this sequence may be requested by the Contractor and may be authorized by the Engineer (with input from the Construction Manager) where necessary to meet other constraints described in these Contract Documents. Any requested changes to the extent of testing quality control checks, related sequencing, and/or level or frequency of documentation shall be considered a deviation from the accepted Commissioning Plan and require resubmittal. The equipment and facility startup is a bottom-up approach, where testing starts at the component level, which is then followed by testing at the system, and then facility level.
    a. Phase 1 Commissioning: Component Test Phase. The Component Test Phase is comprised of the following three parts.
        1) Part 1 – Component Installation Review
        2) Part 2 – Component Operational Test
        3) Part 3 – Component Network Communications Test
    b. Phase 2 Commissioning: Functional Test Phase
        1) Part 1 – Functional Test of Individual Components and Independent Systems
        2) Part 2 – Comprehensive Functional Test of Integrated Systems
    c. Phase 3 Commissioning: Operations Test Phase. The Operations Test Phase is comprised of the following two parts.
        1) Part 1 – Walkdown
        2) Part 2 – Seven (7) Day Operations Test
    d. Phase 4 Commissioning: Acceptance Test Phase
    e. Optimization/Performance Commissioning Phase
2. Unless otherwise specified or agreed to in writing by the Engineer (with input from the Construction Manager), all testing activities required as part of facility construction will occur prior to initiation of Phase 1 Commissioning. These include, but are not limited to, testing hydraulic structures for water tightness, pressure testing of piping systems, etc. Refer to applicable specification sections for specific requirements.

1.02 CONTRACTOR COMMISSIONING MANAGER RESPONSIBILITIES AND QUALIFICATIONS

A. The Contractor shall provide an experienced Commissioning Manager who will be responsible for overseeing, organizing, administering, recording, and documenting all aspects the testing and startup efforts, including development of System Commissioning Plans. Refer to paragraph 1.02 Contractor Commissioning Manager Responsibilities and Qualifications for experience requirements.

B. At 30 days prior to the commencement of the first component testing, the Commissioning Manager shall be full time, working only on the testing and startup activities of this Work.

C. The Commissioning Manager's responsibilities shall include, but are not limited to, the following activities.

1. Direct and oversee the development of all commissioning planning documents.
2. Coordinate and be responsible for all testing and startup activities.

3. Coordinate activities with overall Contractor's project schedule, providing a schedule update at each meeting.
4. Serve as liaison between the Contractor and the Engineer/Construction Manager for all testing and startup activities. Coordinate directly with Owner's staff as directed by the Construction Manager.
5. Organize, lead, and provide minutes for Commissioning Meetings from the initial development of the System Commissioning Plans until the completion of all testing and startup activities.
6. Maintain the System Commissioning Plans and provide monthly updates to the Startup Team until the month prior to startup, then provide weekly updates until commissioning is complete.
7. Oversee and administer all testing activities, including either direct participation in the testing, and/or oversight and monitoring of all testing, and related documentation.
8. Assure that all tests have been successfully completed in accordance with the submitted testing procedures.
9. Develop, compile, review for completeness and compliance to the specifications, and submit all required completed test submittals and other related documentation in a timely manner
10. Work with the Contractor's Safety Supervisor to provide safe work conditions during commissioning.
11. Prior to submittal, review and approve the content of all training sessions to assure that the training includes all applicable operation, maintenance, safety, and functional, operations, and acceptance testing information.

D. Commissioning Manager's Statement of Qualifications:
1. Bachelor's degree in civil, mechanical, or electrical engineering with a minimum of 10 years of construction experience and 5 years of experience serving in a role with responsibilities similar to those described in this Section.
2. Experience in the startup of similar systems on at least one completed water facility, with a minimum construction cost of $20 million; over 300 sheets of drawings; and including pumping, pipelines, equipment, liquid and/or solids treatment process modifications, networked controls, and electrical infrastructure.
3. A minimum of 10 years of construction experience and 5 years of experience serving in a role with responsibilities similar to those described in this Section.
4. Experience in the startup of similar systems on at least one completed water treatment plant facility, with a minimum construction cost of $5 million.

1.03 DEFINITIONS

A. Commissioning:
1. The systematic process composed of all elements and requirements related to testing and startup of the Work.

B. Commissioning Hierarchy:
1. Area
a. A collection of systems usually constructed within or primarily within the confines of a single building or structure.

b. Generally, the Drawings are compiled by Area number, in ascending order. Area numbers used in the Drawings correspond with the numbering system utilized during the last several facility upgrades.

c. In most cases, Areas correspond with treatment processes. In some cases, however, multiple treatment processes are included in the same Area and/or a single treatment process is incorporated into multiple Areas.

2. System
   a. An arrangement of components or other systems so related or connected to perform a specific function and which form an identifiable, unified, functional, operational, safe, and independent part of the Owner's facility.
   b. A system may consist of solely new equipment installed as part of the Work, or as a combination of new equipment installed as part of the Work and existing equipment operating in conjunction with each other.
   c. A system may include equipment and facilities in more than one Area.
3. Component
   a. Components comprise every discrete item associated within the Work.
   b. Example components include but are not limited to the following:
      1) Structural system components include: buildings, tanks and reservoirs.
      2) Architectural system components include: floors, walls, doors, windows, ceilings and roofs.
      3) Process system components are usually discrete pieces of equipment and their respective motors and include: pumps, tanks, blowers, and other types of treatment equipment.
      4) Piping system components include: the piping, the piping connections, and the valves, whether manual or powered.
      5) Electrical system components include: wiring, equipment including but not limited to panelboards, Switchboards, starters, and VFDs.
      6) Control system components include: Wiring, instruments, control panels, human-machine interfaces (HMIs'), computers, programmable logic controllers (PLCs), instrument networks, and process control networks.
      7) Heating, ventilation and air conditioning (HVAC) system components include: pumps discrete pieces of HVAC equipment, and their respective motors and include: pumps, heat pumps, heat exchangers, water quality systems, valves, fans, louvers and ductwork.
      8) Plumbing system components include: pumps, strainers, valves, water supply piping, and area collection/drainage for system
      9) Not used.
      10) Not used.
      11) Security system components include: video surveillance, locking systems, identification systems, access to existing or other systems, and security staffing.
      12) Communication systems, including internet connectivity devices.
      13) Access control systems, including interface to existing and/or other systems.
      14) Indoor and outdoor lighting control systems.

C. Summary of Test Phases. Reference paragraph 3.05 Testing for comprehensive test phase requirements.

1. Phase 1 Commissioning: Component Test Phase. The Component Test Phase is intended to:
    a. Perform inspection and testing in a logical, stepwise sequence to ensure that the installed components have been safely and properly assembled, serviced, aligned, adjusted, connected, and calibrated prior to operation.
    b. Perform operational tests to prove that the components are operating as needed, intended, and specified.
    c. Perform component network communications tests to prove that all network reporting, data received, and control aspects for a given component are being correctly performed as needed, intended and specified.
2. Phase 2 Commissioning: Functional Test Phase. The Functional Test Phase is performed on a system, multiple integrated systems and/or a facility to prove that they function as required in conformance with the performance requirements and as needed, intended and specified. Functional tests use plant water, non-potable water, air, or simulated signals, not the specified media.
3. Phase 3 Commissioning: Operations Test Phase. The Operations Test Phase prepares a system, multiple integrated systems or a facility for the Acceptance Test Phase, proves that all systems are correctly set up and that the facility will reliably function over time in real world conditions. The Operations Test Phase is intended to:
    a. Provide for operations testing to prove compliance with performance requirements using either plant water, non-potable water, air, or the specified media, depending on the tests performed. For systems exposed to untreated or partially treated wastewater, operations testing is the final step prior to introducing the wastewater.
    b. Perform a complete inspection (walkdown) by the commissioning team to verify readiness for the 7-day operational test.
    c. Provide for 7-day operations test which shall consist of a continuous un-interrupted seven-day run period using the specified media.
4. Phase 4 Commissioning: Acceptance Test Phase. The Acceptance Test Phase operates a system, multiple integrated systems or a facility with the specified media, by the Owner (with assistance from the Contractor), for 30 days, without operational or performance failure to demonstrate satisfactory performance with the performance requirements specified. Performance tests, specified in individual specification sections to verify guaranteed performance, are performed during Phase 4 Commissioning.
5. Optimization Commissioning Phase: Some systems may be specified with Optimization Testing which is intended to provide the Manufacturer's services to optimize specific systems.

D. Other Key Terms:

1. Tests: Unless otherwise specified, denotes all field-testing including component tests, functional tests, operational tests, acceptance tests, and optimization/performance tests.
2. Startup Constraints: Startup constraints are identified throughout these Contract Documents with major construction constraints with reference to the effects on process startup are being discussed in Section 01 12 16.

3. Commissioning Team. Led by the Commissioning Manager, the Commissioning Team is comprised of key operations and maintenance personnel of the Navajo Tribal Utility Authority (NTUA), the Construction Manager, the Engineer and key representatives of the Suppliers.
4. Commissioning Manager: A testing and startup expert employed by the Contractor who is responsible for overseeing, organizing, administering, recording, and documenting all aspects the commissioning efforts.
5. Temporary Provision: Outages, re-routes, systems, components, materials, or equipment which is temporarily required to allow any test to occur.
6. Systems Integrator: party responsible for control panel fabrication or alteration
7. Programmer: responsible for configuration of controllers (PLC, DCS, RTUs), HMI software. This may be separate from the party responsible for the control panels, fabrications or alternation, instrument installation and configuration.
8. Vendor Programmer: party responsible for controllers or local interface on vendor package equipment, defined as separate from plant or area SCADA systems.

1.04 SYSTEMS FOR PRE-COMMISSIONING AND COMMISSIONING

A. The following is a list of major areas at the LeChee Water Treatment Plant along with the primary processes and systems located in each area.
   1. Area 10: Raw Water Tank System
      a. Raw Water Tank [T1010]
   2. Area 20: Water Treatment Building
      a. Raw Water Feed Pump System (Area 21)
         1) Raw Water Feed System 1
            a) Raw Water Feed Pump 1 [P2110]
            b) Raw Water Filter [FLT2115]
         2) Raw Water Feed System 2
            a) Raw Water Feed Pump 1 [P2120]
            b) Raw Water Filter 1 [FLT2125]
      b. Membrane Filtration Process (Area 22)
         1) RW Turbidity Panel
         2) Membrane Treatment Skid 1
            a) Valve Rack 1
            b) Permeate Turbidity Panel 1
         3) Membrane Treatment Skid 2
            a) Valve Rack 2
            b) Permeate Turbidity Panel 2
         4) Backwash Water Pumping System
            a) Backwash Water Pump 1 [P2241]
            b) Backwash Water Pump 2 [P2242]
         5) Clean-In-Place [CIP] System
            a) CIP Pump 1 [P2251]
            b) CIP Pump 2 [P2252]

c) CIP Heater [H2250]
d) CIP System Analyzer

6) Sodium Hypochlorite Dosing System
a) Sodium Hypochlorite Pump 1 [P2260]
b) Sodium Hypochlorite Pump 2 [P2261]

7) Citric Acid Dosing System
a) Citric Acid Pump 1 [P2262]
b) Citric Acid Pump 2 [P2263]

8) Sodium Bisulfite Dosing System
a) Sodium Bisulfite Pump 1 [P2264]
b) Sodium Bisulfite Pump 2 [P2265]

9) Sulfuric Acid Dosing System
a) Sulfuric Acid Dosing System 1 [P2266]
b) Sulfuric Acid Dosing System 2 [P2267]

10) Sodium Hydroxide Dosing System
a) Sodium Hydroxide Pump 1 [P2268]
b) Sodium Hydroxide Pump 2 [P2269]

11) Air Scour Blower System
a) Air Blower 1 [B2271]
b) Air Blower 2 [B2272]

12) Compressed Air System
a) Compressor 1 [C2281]
b) Compressor 2 [C2282]
c) Thermal Dryer 1 [D2281]
d) Thermal Dryer 2 [D2282]

c. Pressurized GAC Process System (Area 23)
1) GAC Treatment System
a) Pressure Vessel 1 [PV2310]
b) Pressure Vessel 2 [PV2320]
c) Pressure Vessel 3 [PV2330]

2) GAC Backwash System
a) GAC Backwash Pump [P2300]

d. Chlorine Gas Dosing System (Area 24)
1) Chlorine Containment Vessel
2) Chlorine Gas Dosing System
a) Chlorine Booster Pump 1 [P2421]
b) Chlorine Booster Pump 2 [P2422]
c) Chlorinator 1 [CHL2431]
d) Chlorinator 2 [CHL2432]

e. Sodium Hydroxide Dosing System (Area 25)
1) Sodium Hydroxide Pump 1 [P2510]
2) Sodium Hydroxide Pump 2 [P2520]

f. Backwash Coagulant Dosing System (Area 26)
    1) Coagulant Pump 1 [P2610]
    2) Coagulant Pump 2 [P2620]
g. Plant Water System (Area 27)
    1) Booster Pump 1 [P2710]
    2) Booster Pump 2 [P2720]

3. Area 30: Finished Water Reservoir System
    a. Finished Water Reservoir [T3010]
    b. Treated Water Chlorine Residual Panel
    c. Finished Water Chlorine Residual and pH Panel
4. Area 40: Solids Drying Bed System
    a. Solids Drying Bed 1
    b. Solids Drying Bed 2
    c. Solids Drying Bed 3
    d. Decant Pump 1 [P4051]
    e. Decant Pump 2 [P4052]
5. Area 50: Chemical Drying Bed System
    a. Chemical Drying Bed 1
    b. Chemical Drying Bed 2
6. Area 70: Residuals Handling System
    a. Solids Equalization Tank
        1) Plate Settler Feed Pump 1
        2) Plate Settler Feed Pump 2
    b. Plate Settler Tank
        1) Plate Settlers
        2) Settled Backwash Solids Pump 1
        3) Settled Backwash Solids Pump 2
    c. Settled Backwash Water Tank
        1) Recycled Backwash Water Pump 1
        2) Recycled Backwash Water Pump 2
    d. Solids Valve and Meter Vault
        1) Recycled Backwash Water Sample Panel

1.05 COMMISSIONING PLAN

A. A Master Commissioning Plan for the Work shall be prepared. The Master Commissioning Plan shall be divided into several sub-plans, the first of which is an overall Project Commissioning Plan for the Work, with more detailed System Startup Plans prepared for each system. The number of System Startup Plans is dependent on the number of facilities and systems involved in the Work, the minimum number of which is defined later in this Section.
    1. Project Commissioning Plan. The Project Commissioning Plan shall provide an overview of the efforts related to the testing and startup for the Work. At a minimum this plan shall cover the following.

a. An organizational chart of the Commissioning Team and a description of the roles and responsibilities for each member.
b. A general approach, sequencing and analysis of major constraints at the facility and system level to performing the testing and startup for the Work.
c. A listing and brief description of each system to be commissioned.
d. Updated Construction progress schedule (see Section 01 32 16) which integrates the commissioning plan and schedule into the overall construction schedule. The updated schedule shall identify the schedule duration of each of the system commissioning activities specified in paragraph 1.05 B below; detailed schedule of each system commissioning activity can be provided with each system commissioning plan, as specified in paragraph 1.05 B.3 below.

B. System Commissioning Plans. A System Commissioning Plan shall be created for each system identified in paragraph 1.04 Systems for Pre-Commissioning and Commissioning. The System Commissioning Plan shall be kept updated as testing progresses. At a minimum these plans shall include the following.
1. System Description. Provide a description of the system and each facility and area(s) into which that the system extends.
2. Testing Descriptions and Sequencing
a. Overall Testing Description
1) Provide a summary of the testing activities to be performed for that system.
2) Provide a summary of the sequencing of the testing to be performed for the system.
3) Provide a description of how signals from existing equipment not yet integrated into the work, or from new equipment that cannot yet be actuated, will be simulated or actuated in order to test the system.
b. Component Testing
1) Provide a listing, description and sequencing of each component test.
2) The sequencing of the component testing shall be optimized to minimize the length of the phase.
3) Record of field or factory calibration such as for instruments, or configuration specific to requirements specified such as VFD settings.
4) Instrumentation and control loop tests.
5) Electrical acceptance tests.
6) Arc flash hazard and protective device requirements of Division 26.
c. Functional Testing
1) For each system, or multiple integrated systems or facilities which will undergo functional testing, provide a list, description and sequencing of each functional test. The description shall include a narrative of the scenarios to be tested and shall include how the full operational range will be tested.
a) Local control of all equipment and systems must be tested first. Successful testing of any field interlocks and hardwired controls before proceeding to remote control.
b) Local control and remote check out are to be structured around the submitted I/O list, as specified in Division 40.

c) All field terminations, loop checks, and modification within a control panel must be complete commencement of functional testing.

2) Project process and instrumentation diagrams (P&IDs) shall be marked-up and provided which schematically represent the process and controls of the final construction of the system and shall be marked up noting temporary features necessary for Functional testing.

d. Operations Testing

1) For the system, provide a description of the walkdown process.

2) For the system, provide a list, description and sequencing of each startup test. The description shall include a narrative of the scenarios to be tested and shall include how the full operational range will be tested.

3) Project P&IDs shall be marked-up and provided that schematically represent the process and controls of the final construction and shall be marked up noting temporary features necessary for Operations Testing.

4) Plan drawings shall also be provided, marked up to show the final construction and temporary features required for Operations Testing.

e. Acceptance Testing

1) For the system, provide a list, description and sequencing of each acceptance test.

f. Optimization/Performance Testing

1) If required for the facility, provide a list, description and sequencing of each optimization/performance test.

3. Comprehensive Testing Schedule

a. For each System Commissioning Plan, list all equipment to be tested by specification section number and name, and provide a comprehensive schedule showing the following for each.

1) Section number and/or paragraph number within a section.

2) Forecasted installation completion dates.

3) Forecasted visit dates by the manufacturer.

4) The system within which each equipment item is included and will be tested.

5) Forecasted start and completion for each test (component, functional, operations, acceptance).

6) Forecasted submittal dates for test reports.

b. Update Comprehensive Testing Schedule monthly and coordinate it with the Overall Project Schedule.

4. Control Descriptions. Provide a listing of the control description(s) involved. Provide control descriptions as part of the System Commissioning Plan.

5. Drawings. Provide a listing of the following drawings.

a. All drawings that are part of the Contract Documents and are directly related to the facility undergoing testing.

b. Shop drawings including wiring diagrams relevant to the facility.

c. List of package system PLCs and their I/O's and wire diagrams for the system.

6. Instruments. Provide a list of the instruments involved with an appendix which includes the correct set points and ranges for the instruments.

7. Testing Consumables. Provide tables with descriptions that describe the consumables and estimated quantities required during testing, including but not limited to potable water, plant water, chemicals, fuels, oils, lubricants and filters.
8. Testing Equipment Calibration. Provide a description of the measurement devices and the calibration method for the measurement devices which will be used to measure process performance characteristics.
9. Temporary Provisions
    a. Provide a listing and description of temporary provisions required to perform all tests, including calibration equipment.
    b. Where testing requires a source of water, gas or other medium other than the process fluid, identify the source of the water or fluid, the temporary provisions to employed to deliver the water or fluid to the testing location, the temporary provisions to circulate the water or fluid through the facilities to be tested.
    c. Identify the location and method of disposal of the test media (water or fluid, or specified media). Identify temporary provisions required to safely deliver spent media to point of disposal.
10. Hazard Analysis. Provide a description of each potential hazard during the testing activities in the facility and mitigation measures planned for each.
11. A listing of and a short resume for the Manufacturer's representatives who will be involved in testing.
12. Forms: Provide in an appendix with each form and checklist to be used. Starting with forms provided in Section 01 99 90, edit each form to make specific to the components included in each System to be commissioned. Provide additional forms as needed to fully document the commissioning activities specified.

1.06 MANUFACTURER'S FIELD SERVICES

A. Where manufacturer's services are specified in this Section or other specification sections, furnish an authorized representative of the manufacturer who is factory-trained, knowledgeable and experienced in the technical aspects of their products and systems supplied on the Project and qualified to provide these services. Manufacturer representatives shall be available during equipment installation, commissioning and training of Owner's personnel.

B. Manufacturer's representatives shall be subject to the acceptance of by the Construction Manager and Engineer as a submittal with each System Commissioning Plan. No substitute representatives will be allowed without prior written approval from the Construction Manager.

C. Manufacturer's Certifications:
    1. After equipment installation and before equipment energization, each manufacturer's representative shall prepare a written Manufacturer's Installation Certification Form, Form 43 05 11-A in Section 01 99 90, certifying that each equipment specified in Divisions 26 through 46 that the manufacturer supplied is properly installed and lubricated, has been properly maintained by the Contractor, is in accurate alignment, is free from any undue stress imposed by connecting piping and anchor bolts, and is in accordance with the manufacturer's installation instructions.

2. During Phase 4 Commissioning, each manufacturer's representative shall prepare a written Manufacturer's Operation Certification Form, Form 43 05 11-D in Section 01 99 90, certifying that each equipment specified in Divisions 26 through 46 that the manufacturer supplied is properly lubricated; has been properly maintained by the Contractor; is in accurate alignment; is free from any undue stress imposed by connecting piping and anchor bolts; and has been operated under all design conditions and meets the performance criteria in accordance with the requirements in the applicable specification sections and the manufacturer's operating requirements.

D. The Manufacturer's authorized representative shall perform all services when Manufacturer's services are specified in the individual specification sections. The authorized representative shall be factory-trained and experienced in the technical applications, installation, operation and maintenance of the equipment, subsystem or system.

E. The scheduling of all visits to the site by the manufacturer's field services representative shall be determined by the Contractor and coordinated through the Commissioning Manager. The Contractor shall notify the Construction Manager a minimum of 7 days in advance of all visits.

F. The Manufacturer’s authorized representative shall not independently determine any requirements can be omitted, reduced or otherwise change testing requirements, protocols, or required documentation without submitting a request for deviation to the accepted Commissioning Plan or other related submittals.

1.07 SUBMITTALS

A. Action Submittals: The following minimum submittals shall be submitted in accordance with Section 01 33 00.

1. Within 60 days following Notice to Proceed.
    a. A copy of this Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification requirements or those parts which are to be provided by the Contractor or others shall be provided. Check marks (") shall denote full compliance with a paragraph as a whole.
    b. If deviations from the Specifications are indicated, and therefore requested, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations.
    c. The remaining portions of the paragraph not underlined shall signify compliance with the Specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the requirements of the Specification shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.
    d. Commissioning Manager qualifications and past work experience including contact names, addresses, and current telephone numbers that can be used to verify the accuracy of the provided information.

2. Within 120 days following Notice to Proceed.
    a. Master Commissioning Plan.
3. Not less than 120 days prior of the initiation of the first planned component testing in a system.
    a. System Commissioning Plan for the system within which the first components will be tested. Submit system test plans in two parts as described below:
        1) Submit the portion of the system commissioning plan for Component and Functional testing.
        2) After successful completion of the Component testing, submit the test plan for the remaining phases of testing and commissioning.
    b. Submit remaining System Commissioning Plans not less than 120 days prior to first planned component testing within each system, following the same two-part submittal process described above.
4. Qualifications of equipment manufacturer's representatives, to be submitted with each System Commissioning Plan.
5. Within 7 days following completion of each phase of Commissioning for each System Commissioning Plan, submit documentation demonstrating successful completion of the testing phase for that system. Any issues identified during the testing phase shall be identified along with the actions taken, or planned to be taken, to rectify the issue.
6. Certificates of instrument calibration, provided upon request from the Construction Manager or Engineer.

B. Informational Submittals: The following minimum informational submittals shall be submitted in accordance with the timing requirements specified in these Contract Documents, prior to Substantial Completion and in accordance with Section 01 33 00.
    1. Updates to Comprehensive Testing Schedule.

C. Closeout Submittals: The following minimum closeout submittals shall be submitted in accordance with the timing requirements specified in these Contract Documents, prior to Substantial Completion and in accordance with Section 01 33 00.
    1. Manufacturer's Certificates of Proper Installation, Form 43 05 11-A in Section 01 99 90, or reference to completed certificates provided under separate submittals where specified.
    2. Test Reports, including completed test forms as specified in Section 01 99 90, and paragraph 1.05 Commissioning Plan, or reference to completed test forms provided under separate submittals where specified.
    3. Certificate of Testing and Commissioning
    4. Certificate of Training Completion, Form 43 05 11-B in Section 01 99 90, or reference to completed Certificates of Training Completion provided under separate submittals where specified.
    5. Manufacturer's Certificates of Proper Operation, Form 43 05 11-D in Section 01 99 90, or reference to completed Manufacturer's Certificate of Proper Operation provided under separate submittals where specified.

D. Samples:
    1. Reference the individual specifications within the Contract Documents for items requiring samples to be submitted.

E. Mock-ups:
   1. Reference the individual specifications within the Contract Documents for items requiring mock-ups to be submitted.

PART 2 PRODUCTS

2.01 TEST MATERIALS AND EQUIPMENT

A. Provide calibrated test gauges, meters, recorders and monitors, reagents and test gases and associated assemblies, as required, to supplement or augment the Work specified in the Contract Documents to facilitate compliance with requirements of the commissioning. Select devices designed to measure the performance of the specific equipment and systems incorporated into the Work.

B. When testing requires the use of temporary provisions such as, but not limited to equipment, power, compressed air, or instrumentation which have not yet been placed in service, provide substitute sources acceptable to both the Owner and Construction Manager, and capable of meeting the requirements needed to perform the testing.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall install all equipment in accordance with Manufacturer's requirements and the Contract Documents. Notify the Engineer/Construction Manager of any conflict between a manufacturer's installation recommendations and the Contract Documents.

B. The Contractor shall perform component testing, functional testing, and startup testing, of all installed component and systems. Unless specified otherwise, the Owner shall be responsible for operating the facility during acceptance testing, with assistance and support from the Contractor in performing specific testing activities.

C. The Contractor shall provide the services of all technical and craft personnel required to support the Work throughout the duration of all testing phases, except as otherwise noted in this Section.

D. The Contractor shall maintain the appropriate staff (either on-site or on-call) to be able to respond immediately (24-hours per day) to deficiencies discovered during the Operations Test Phase and the Acceptance Test Phase. The Contractor's qualified personnel must be capable of being on-site within a maximum of 2 hours of notice to correct any deficiencies.

E. Until completion of the Acceptance Test Phase, the Contractor shall maintain all facilities undergoing testing. This includes, but is not limited to, manufacturer recommended preventative maintenance, repairs as needed, consumables such as lubricants, coating touch-up, etc.

F. The Contractor shall provide temporary systems, piping, valving, drains, power, controls, etc. to facilitate any of the tests, as needed to cycle water or air through the facilities in a manner that simulates the ultimate operation of the system.

G. All testing that may affect the operation of the existing facilities shall be coordinated with the Owner, including the proper isolation (e.g., lock out/tag out) procedures and features prior to commencing Work.

H. Timing of Testing:
   1. No testing shall commence until the related specific System Commissioning Plan has been submitted, reviewed, and received a review action of No Exceptions Taken, or Make Corrections Noted.
   2. No testing shall commence until the O&M Manual for the equipment involved has been reviewed and received a review action of No Exceptions Taken or Make Corrections Noted.
   3. Progression from one test phase to the next shall only be allowed at the written approval of the Construction Manager, following submission of written documentation from the Contractor signifying that the intent of that testing phase has been met with satisfactory results. The written approval will include a listing of items still owed by the Contractor regarding the testing which has occurred.
   4. Operations Testing shall not commence until all tagging and labeling including but not limited to piping, conduit, wires, panels, and equipment, have been completed.
   5. Acceptance Testing shall not commence until training has been completed.
   6. All life-safety systems, including but limited to ventilation, fire monitoring and alarms, hazard monitoring and alarms, communication systems, associated with a specific system, must have successfully completed operations testing prior to proceeding with Functional Testing of the system.

I. At the satisfactory conclusion of each test phase, the Contractor shall dismantle and remove all temporary valving, hoses, and other equipment used during the test, and return the facilities to conditions as existed before the test.

J. All deficiencies found during any test phase and subsequent correction thereof, must be inspected and approved by the Construction Manager prior to re-testing or continuation of testing. The contractor shall correct all noted deficiencies.

3.02 TESTING AND STARTUP MEETINGS AND WEEKLY REPORTS

A. The Commissioning Manager shall conduct regular commissioning meetings.

B. The first meeting shall be at least 6 months prior to submitting the Project Commissioning Plan and shall include preliminary discussions regarding this plan. Commissioning meetings shall then be held monthly until 120 days prior to the first planned Component Testing. Ongoing development of the individual System Commissioning Plans will be among the topics discussed in these meetings.

C. At a point commencing 120 days prior to the first Component Test Phase, the commissioning meetings shall be held weekly.

D. Commissioning meetings shall be attended by the Construction Manager, key members from the Contractor staff, Subcontractors, key representatives of the Manufacturers, along with representatives for the Owner and the Engineer.

E. The Commissioning Manager shall prepare meeting minutes from the Testing and Start-up and distribute to all attendees not later than 3 days prior to the next meeting, or within 5 working days of each meeting, whichever is sooner. These should be issued as draft with a request for comments within 3 business days, followed by a final issuance.

F. Weekly Test Reports:
   1. During testing activities, submit weekly test reports describing the tests performed, test methods, test strategies implemented during the test, summary of successful testing completed, and specific highlight of any problems and/or deficiencies found during testing.
   2. For all troubleshooting, describe the troubleshooting strategy, methods, and final resolution.

3.03 EQUIPMENT AND MATERIALS REQUIRED FOR TESTING

A. It shall be the Contractor's responsibility to ensure that all required materials and test and repair equipment are on hand during all planned testing activities. Spare parts, specified to be provided as part of the work, shall not be used for testing without the written approval of the Construction Manager.

B. All instruments used to measure performance shall be calibrated. Certificates of calibration shall be current (as required in Division 40), and shall be at the job site during testing, and provided upon request or when specified.

C. Contractor is required to provide all expendables during all tests (not including Acceptance Testing, unless otherwise specified), including but not limited to, chemicals, fuel, oil and filters (e.g., air, fuel, natural gas, oil, media, etc.). Upon completion of Operational Testing (or Acceptance Testing, where specified) all expendables shall be replaced with new.

3.04 TEMPORARY PROVISIONS

A. Maintain temporary provisions until the testing phase requiring the temporary facilities are complete, or until the permanent facilities are in service where specified.

3.05 TESTING

A. Phase 1 Commissioning: Component Test Phase: The Component Test Phase shall be comprised of the following three parts.
   1. Part 1 – Component Installation Review
      a. Perform inspection and testing in a logical, stepwise sequence to ensure that the installed components have been safely and properly assembled, serviced, aligned, adjusted, connected, and calibrated prior to operation.
      b. Perform all changes, adjustments, and replacements required to make the equipment operate properly.
      c. The Component Installation Review includes but is not limited to the following activities.
         1) Verification of adherence to manufacturer's installation and pre-startup requirements and procedures.

2) For structures and tanks, perform and confirm compliance of structural leakage tests in accordance with Division 03 of these specifications.
3) For piping, perform and confirm compliance of piping testing in accordance with Section 40 05 01.
4) Verify wiring continuity for all components, equipment, instruments, panels, and devices. Check power, control, and monitoring circuits for continuity prior to connection to power source. Reference Division 26 and Division 40 for additional specifics regarding installation review of electrical and controls components including, but not limited to:
    a) Electrical acceptance tests per Section 26 08 00, complete.
    b) Arc flash hazard and coordination study, protective device settings, and labeling completed.
5) Confirm cleanliness of connecting piping systems.
6) Confirm alignment of connected machinery.
7) Confirm correct lubrication.
8) Confirm valve orientation and position status for manual operating mode.
9) Confirm correct tagging and identification
10) Confirm proper functioning of all safety components.
11) Confirm proper connections, alignment, calibration and adjustment.
12) Manually rotate or move all moving parts to assure freedom of movement.
13) Confirm all safety equipment is installed per contract requirements, including but not limited to eye wash stations, warning signs, ventilation systems and equipment, etc.
14) Provide Manufacturer's Certificate of Proper Installation following the completion of this review.

2. Part 2 – Component Operations Test
    a. Perform testing showing that the component is operating as needed, intended, and specified for the Work including but not limited to the following.
        1) Bump electric motors to verify power and direction of rotation.
        2) Verify correct voltage and phase sequence of all circuits.
        3) Verify correct amperage.
        4) Loop tests per Section 40 61 21.
        5) Complete testing of all control circuits including interlocks.
        6) Verify that every component is operational through its entire range of operation.
    b. Reference Division 26 and Division 40 for specific execution requirements related to electrical and instrumentation components and systems.
    c. Unless otherwise specified or allowed by the Construction Manager, the test media for component operational testing shall be plant water or non-potable water.
3. Part 3 – Component Network Communications Test
    a. The component network communication tests shall prove that all network reporting, data received, and control aspects for a given component are being correctly performed as needed, intended, and specified.

b. Perform network tests for all network panels, network hardware, network cables, and all other network systems that are required to be installed and operational for each component.

c. Refer to Division 40 for specific execution requirements for the component network tests.

B. Phase 2 Commissioning: Functional Test Phase:

1. Functional testing shall be performed on all components and systems as required to prove that they function as required in conformance with the performance requirements and as needed and intended to complete the Work. All components of a system shall be operated together during functional testing.

a. The Functional Test Phase is required for all process equipment, HVAC equipment, other equipment, piping, electrical, instrumentation, controls, and package system equipment.

b. Testing for all DCS controls associated with all components with DCS monitoring or DCS controls shall be performed. This test shall include testing of multiple components that have interfaces between them. For packaged equipment this shall include testing of interfaces and interlocks between equipment supplied by the Supplier of the packaged equipment and equipment supplied in other technical specification sections.

c. When testing requires the use of auxiliary systems such as electrical power, compressed air, control air, or instrumentation which have not yet been placed in service, provide acceptable substitute sources, capable of meeting the requirements of the component or system.

d. Functionally test each system as an independent system.

1) Tests shall include all the functional requirements provided in Division 26 and Division 40, within the individual requirements in the Specifications and as required by the Supplier.

2) Demonstrate that each, and every, component within the system interacts and functionally operates as specified throughout its entire range of operation.

3) Test each interlock for the system, all local controls, and all DCS controls.

e. Functionally test multiple integrated systems. The testing shall include individual components and systems that were previously tested independently.

1) Test in a step-by-step method to accomplish orderly and systematic testing of integrated systems to simulate the functionality of the completed Work.

2) Tests shall be run through normal operating ranges and to prove specific performance requirements as required by the Specifications or otherwise needed to prove compliance with the Specifications.

3) To the greatest extent practical, test at conditions which represent the full range of operating parameters (or specified test parameters if greater) as defined in the Contract Documents.

4) The tests shall include all network controls, all network interlocks, all inter-process interlocks, and all operations interfaces.

5) The tests shall be performed until the specified operating modes or performance has been accomplished without interruption for the specified duration as indicated in the Specifications or in no instance less than 4 hours.

6) Should the functional testing of the integrated systems be halted for any reason, the testing shall be repeated until it has been accomplished without interruption.

7) Coordinate with Construction Manager such that Construction Manager can witness each individual step in the procedures.

f. Following the testing perform the following.

1) Check equipment for loose connections, unusual movement or other indications of improper operating characteristics.

2) Disassemble and inspect equipment which exhibits unusual or unacceptable operating characteristics. Re-align machines identified as out of alignment. Repair, or remove and replace with new if unable to pass the requirement of the testing. Test until the equipment meets the requirements of the Specifications.

g. Unless otherwise specified or allowed by the Construction Manager and Engineer, the test media for functional testing shall be the water identified in the System Commissioning Plan (e.g., plant water, non-potable water, air, or specified media, depending on the system).

C. Phase 3 Commissioning: Operations Test Phase:

1. General Requirements of the Operations Test Phase

a. Tests shall be performed using the specified media.

b. Disposal of test media shall follow all laws and regulations and with proper permits.

c. Unless otherwise indicated in these Contract Documents or permitted by the Construction Manager, training shall be performed during the Operations Test Phase.

d. The Operations Test Phase shall be conducted at a time and date which is requested by the Contractor and agreed to by the Owner.

e. Coordinate with the Owner for introduction of specified media, disposal (or return to treatment plant) of specified material, and operation of facilities with specified media.

f. Prior to commencement of the Operations Test Phase, the facility shall be fully operational, capable of accepting design flows and performing functions as designed.

g. The Operations Test Phase shall test for normal operational sequence as an integrated system conforming to the requirements of the Specifications through full specified operating range. Test network control logic across multiple systems.

h. During the Operations Test Phase, tests shall be executed for all components. Tests shall include all the operations tests as specified in the individual equipment technical specification sections. This includes vibration tests where specified.

i. Provide required support to the Owner such that the facility attains its fully operational mode.

2. Part 1 -Walkdown: After the completion of the functional testing, a complete inspection by the Startup Team shall be performed to determine if the facility is ready for the Seven (7) Day Operational Test.

a. Walk through the facility with the Construction Manager, the Owner, and the Engineer to acknowledge facility is ready for the Seven (7) Day Operational Test.
b. A working punch-list will be developed and provided by the Construction Manager.
c. The punch-list shall be identified by the following ranking criteria:
1) Level 1: Significant impact item and no further tests shall be performed until resolved. Requires a signoff prior to proceeding.
2) Level 2: Minimal impact item that can be corrected later and does not affect continuation of testing.

3. Part 2 - Seven (7) Day Operational Test. The Operations Test Phase shall consist of a continuous un-interrupted seven-day run period using the specified media.

D. Phase 4 Commissioning: Acceptance Test Phase:
1. The Acceptance Test Phase shall be a test of a system or multiple systems by the Owner using the specified media, without operational or performance failure to demonstrate conformance with the performance requirements specified. The minimum duration of the Acceptance Test Phase shall be 30 days, unless otherwise specified within individual equipment specifications. This is the final test to demonstrate the facility including new and existing processes operate together as needed, intended, and specified.
a. During this test, vary operational parameters during the day, with steady state conditions overnight.
b. Conduct performance testing where required in individual specification sections. Where practical, coordinate timing of performance testing to fall within the nominal 30 days allocated for Acceptance Testing; however, performance testing outside of this 30-day period may be required in order to fully comply with specified performance testing requirements.
c. The Acceptance Test Phase shall be judged completed wholly at the discretion of the Engineer with input from the Construction Manager.
d. This test may last significantly longer than the specified calendar days listed if deficiencies are found, and the test is restarted one or more times. The Contractor shall coordinate with the Owner and provide support as necessary.
e. After satisfactory completion the facility shall be placed into normal operation.
f. Provide documentation of successful performance testing where required in individual equipment specifications.
g. Provide Manufacturer's Certificates of Proper Operation.

E. Optimization Testing:
1. Provide optimization testing as required in individual equipment specifications.

3.06 RETESTS

A. If any portion of a test does not pass, the Contractor shall correct the problem in a timely manner and repeat the test until it passes to the satisfaction of the Engineer and Owner.
1. Functional testing of equipment or a system shall be considered complete when, in opinion of the Engineer and Construction Manager, the system, facility, or designated portion has operated in manner intended for (7) continuous days without significant interruption, unless otherwise agreed upon.

2. Operational testing of the system, the entire facility or any portion thereof shall be considered complete when, in opinion of the Engineer and Construction Manager, the system, facility, or designated portion has operated in manner intended for (28) continuous days without significant interruption, unless otherwise agreed upon.
3. Significant Interruption: May include any of the following events:
    a. Failure of Contractor to provide and maintain qualified onsite startup personnel as scheduled.
    b. Failure of any critical equipment or unit process that is not satisfactorily corrected within 6 hours after failure.
    c. Failure of any noncritical equipment or unit process that is not satisfactorily corrected within 24 hours after failure.
4. Operational testing of the system, the entire facility or any portion thereof shall be considered complete when, in opinion of the Engineer and Construction Manager, the system, all specified testing has been successfully completed, and all deficiencies have been corrected.

B. If a failure of any component or system occurs during any phase of commissioning, the entire phase shall be re-started. If the Commissioning Manager determines that the failure is minor and recommends continuation of the test rather than re-starting, then the Commissioning Manager shall request continuation in writing to the Construction Manager and Engineer, who, if in agreement, may permit continuation of testing.

C. If a failure of any component should occur during any phase of commissioning, the Contractor shall be responsible for the actual cost of any idle time due to such failure. Such costs of idle time shall include personnel costs of Owner's, Construction Manager's, and Engineer's staff who are assigned to coordinate, assist and witness the commissioning activities. This includes personnel costs, rental costs of equipment and any other incidental costs of the delay.

3.07 AFTER TESTS

A. Once testing has been completed, and until the Construction Manager has issued a certificate of Final Completion, all equipment shall be rechecked once by the Contractor (or more often if specified) for proper alignment and realigned, if necessary. All equipment shall be checked for loose connections, unusual movement, or other indications of improper operating characteristics. Any deficiencies shall be corrected to the satisfaction of the Construction Manager. All equipment or devices which exhibit unusual or unacceptable operating characteristics shall be disassembled, inspected and shall then be repaired or removed from the Site and replaced at no cost to the Owner.

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SECTION 01 99 90

REFERENCE FORMS

PART 1 FORMS

1.01 DESCRIPTION

A. The forms listed below and included in this section are referenced from other sections of the project manual:

Form No.	Title
01 33 00-A	Submittal Transmittal Form
01 45 20-A	Equipment Test Report Form
01 78 23-A	Operation and Maintenance Transmittal Form
01 78 23-B	Equipment Record Form
01 78 23-C	Equipment Record Form
09 90 00-A	Coating System Inspection Checklist
26 05 00-A	Wire and Cable Resistance Test Data Form
26 05 00-B	Installed Motor Test Data Form
26 05 00-C	Dry Transformer Test Data Form
26 05 00-M	Starter Panel Test Form
40 61 13-A	Loop Wiring and Insulation Resistance Test Data Form
40 61 13-D	Panel Indicator Calibration Test Data Form
40 61 13-F	Signal Trip Calibration Test Data Form
40 61 13-G	Field Switch Calibration Test Data Form
40 61 13-H	Transmitter Calibration Test Data Form
40 61 13-I	Miscellaneous Instrument Calibration Test Data Form
40 61 13-J	Individual Loop Test Data Form
40 61 13-K	Loop Commissioning Test Data Form
40 61 13-L	Telemtry PLC Control Panel Test Data Form
40 61 13-M	Telemetry Radio Test Data Form
43 05 11-A	Manufacturer's Installation Certification Form
43 05 11-B	Manufacturer's Instruction Certification Form
43 05 11-C	Unit Responsibility Certification Form
43 05 13-A	Rigid Equipment Mount Installation Inspection Checklist
43 05 21-A	Motor Data Form

01 33 00-A. SUBMITTAL TRANSMITTAL FORM

Submittal Transmittal

Submittal Description:	Submittal No:[1]	Spec Section:

	Routing	Sent	Received
Owner:	Contractor/CM		
Project:	CM/Engineer		
	Engineer/CM		
Contractor:	CM/Contractor		

We are sending you:
☐ Attached
☐ Under separate cover via _____
☐ Submittals for review and comment
☐ Product data for information only

Remarks: _____

Item	Copies	Date	Section No.	Description	Review action[a]	Reviewer initials	Review comments attached

[a]*Note: NET = No exceptions taken; MCN = Make corrections noted; A&R = Amend and resubmit; R = Rejected*
Attach additional sheets if necessary.

Contractor

Certify either a or b:

a. ☐ We have verified that the material or equipment contained in this submittal meets all the requirements, including coordination with all related work, specified (no exceptions).

b. ☐ We have verified that the material or equipment contained in this submittal meets all the requirements specified except for the attached deviations.

No.	Deviation

Certified by: _____

Contractor's Signature: _____

[1]See *Section 01 33 00-1.04. A, Transmittal Procedure.*

01 45 20-A. EQUIPMENT TEST REPORT FORM

NOTE: This example equipment test report is provided for the benefit of the Contractor and is not specific to any piece of equipment to be installed as a part of this project. The example is furnished as a means of illustrating the level of detail required for the preparation of equipment test report forms for this project.

Navajo Nation Department of Water Resources

Example Water Treatment Plant

Stage IV Expansion Project

ABC Construction Company, Inc., General Contractor
XYZ Engineering, Inc., Construction Manager

Equipment Test Report

- Equipment Name: Sludge Pump 2
- Equipment Number: P25202
- Specification Ref: 11390
- Location: East Sedimentation Basin Gallery

	Contractor		Construction Manager	
	Verified	Date	Verified	Date
A. Preoperational Checklist				
1. Mechanical				
a. Lubrication				
b. Alignment				
c. Anchor bolts				
d. Seal water system operational				
e. Equipment rotates freely				
f. Safety guards				
g. Valves operational				
h. Hopper purge systems operational				
i. Sedimentation tank/hopper clean				
j. O&M manual information complete				
k. Manufacturer's installation certificate complete				
2. Electrical (circuit ring-out and high-pot tests)				
a. Circuits:				
1) Power to MCC 5				
2) Control to HOA				
3) Indicators at MCC:				
a) Red (running)				
b) Green (power)				
c) Amber (auto)				
4) Indicators at local control panel				
b. Wiring labels complete				
c. Nameplates:				
1) MCC				
2) Control station				
3) Control panel				

	Contractor		Construction Manager	
	Verified	Date	Verified	Date
d. Equipment bumped for rotation				
3. Piping Systems				
a. Cleaned and flushed:				
1) Suction				
2) Discharge				
b. Pressure tests				
c. Temporary piping screens in place				
4. Instrumentation and Controls				
a. Flowmeter FE2502F calibration				
1) Calibration Report No.				
b. Flow recorder FR2502G calibrated against transmitter				
c. VFD speed indicator calibrated against independent reference				
d. Discharge overpressure shutdown switch calibration				
e. Simulate discharge overpressure Shutdown				
B. Functional Tests				
1. Mechanical				
a. Motor operation temperature satisfactory				
b. Pump operating temperature satisfactory				
c. Unusual noise, etc?				
d. Pump operation: 75 gpm/50 psig				
(1) Measurement:				
(a) Flow:				
(b) Pressure:				
(c) Test gage number:				
e. Alignment hot				
f. Dowelled in				
g. Remarks:				
2. Electrical				
a. Local switch function:				
1) Runs in HAND				
2) No control power in OFF				
3) Timer control in AUTO				
b. Overpressure protection switch PS2502C functional in both HAND and AUTO				
c. Overpressure protection switch PS2502C set at 75 psig				
d. PLC 2500 set at 24-hour cycle, 25 min ON				
C. Operational Test				
1. 48-hour continuous test. Pump cycles as specified, indicators functional, controls functional, pump maintains capacity, overpressure protection remains functional, hour meter functional				

RECOMMENDED FOR BENEFICIAL OCCUPANCY:

Construction Manager	Date

ACCEPTED FOR BENEFICIAL OCCUPANCY

Owner's Representative	Date

01 78 23-A. OPERATION AND MAINTENANCE TRANSMITTAL FORM

Date:	Submittal No:[2]
To:	Contract No:
	Spec. Section:
	Submittal Description:
Attention:	From:

Checklist	Contractor		Construction Manager	
	Satisfactory	N/A	Accept	Deficient
1. Table of contents				
2. Equipment record forms				
3. Manufacturer information				
4. Vendor information				
5. Safety precautions				
6. Operator prestart				
7. Start-up, shutdown, and postshutdown procedures				
8. Normal operations				
9. Emergency operations				
10. Operator service requirements				
11. Environmental conditions				
12. Lubrication data				
13. Preventive maintenance plan and schedule				
14. Troubleshooting guides and diagnostic techniques				
15. Wiring diagrams and control diagrams				
16. Maintenance and repair procedures				
17. Removal and replacement instructions				
18. Spare parts and supply list				
19. Corrective maintenance man-hours				
20. Parts identification				
21. Warranty information				
22. Personnel training requirements				
23. Testing equipment and special tool information				

Remarks:

Contractor's Signature :

[2] See Section 01 33 00-1.04.A, Transmittal Procedure.

01 78 23-B. EQUIPMENT RECORD FORM

Equip Descrip		Equip Loc	
Equip No.	Shop Dwg No.	Date Inst	Cost
Mfgr		Mfgr Contact	
Mfgr Address			Phone
Vendor		Vendor Contact	
Vendor Address			Phone

Maintenance Requirements	D	W	M	Q	S	A	Hours

Lubricants: Recommended:

Alternative:

Misc. Notes:

Recommended Spare Parts					Electrical Nameplate Data			
Part No	Quan	Part Name	Cost		Equip			
					Make			
					Serial No.		Id No.	
					Model No.		Frame No.	
					Hp	V	Amp	Hz
					Ph	Rpm	Sf	Duty
					Code	Insl. Cl	Des	Type
					Nema Des	C Amb	Temp Rise	Rating
					Misc.			
					Mechanical Nameplate Data			
					Equip			
					Make			
					Serial No.		Id No.	
					Model No.		Frame No.	
					Hp	Rpm	Cap	Size
					Tdh	Imp Sz	Belt No.	Cfm
					Psi	Assy No.	Case No.	
					Misc			

01 78 23-C. EQUIPMENT RECORD FORM

Equip Descrip		Equip Loc	
Equip No.	Shop Dwg No.	Date Inst	Cost
Mfgr		Mfgr Contact	
Mfgr Address			Phone
Vendor		Vendor Contact	
Vendor Address			Phone

Maintenance Requirements	D	W	M	Q	S	A	Hours

09 90 00-A COATING SYSTEM INSPECTION CHECKLIST

Project Name			
Owner		Coating System Manufacturer (CSM)	
General Contractor (GC)		Coating System Applicator (CSA)	
Area or Structure		Location within Structure	
Coating System (eg E-1)		Coating Type (eg Epoxy, etc.)	

Coating System Inspection Checklist

Step	Description		Name	Signature	Date
1	Completion of cleaning and substrate decontamination prior to abrasive blast cleaning.	GC QC			
		CSM QC			
		CSA QC			
2	Installation of protective enclosure of structure or area and protection of adjacent surfaces or structures that are not to be coated.	GC QC			
		CSM QC			
		CSA QC			
3	Completion of ambient condition control in structure or building area and acceptance of ventilation methods in structure or Area.	GC QC			
		CSM QC			
		CSA QC			
4	Completion of Surface Preparation for Substrates to Be Coated.	GC QC			
		CSM QC			
		CSA QC			
5	Completion of Primer Application.	GC QC			
		CSM QC			
		CSA QC			
6	Completion of Concrete Repairs If Required and Related Surface Preparation Rework Prior to Coating System Application.	GC QC			
		CSM QC			
		CSA QC			
7	Completion of Concrete Filler/ Surface Application to Concrete.	GC QC			
		CSM QC			
		CSA QC			
8	Completion of First Finish Coat Application and of Detail Treatment at Transitions or Terminations.	GC QC			
		CSM QC			
		CSA QC			

Coating System Inspection Checklist

Step	Description		Name	Signature	Date
9	Completion of Second Finish Coat Application and of Detail Treatment at Transitions and Terminations.	GC QC			
		CSM QC			
		CSA QC			
10	Completion of Full and Proper Cure of Coating System.	GC QC			
		CSM QC			
		CSA QC			
11	Completion of Testing of Cured Coating System including Adhesion, Holiday (Continuity) Testing and Dry Film Thickness.	GC QC			
		CSM QC			
		CSA QC			
12	Completion of Localized Repairs to Coating System Following Testing.	GC QC			
		CSM QC			
		CSA QC			
13	Final Acceptance of Coating System Installation Including Final Clean-Up Complying with Specification Requirements and the CSM's Quality Requirements.	GC QC			
		CSM QC			
		CSA QC			

26 05 00-A. WIRE AND CABLE RESISTANCE TEST DATA FORM

Wire or Cable No.:_____ Temperature, °F: _____

Location of Test	Insulation resistance, megohms
1.	
2.	
3.	
4.	
5.	
6.	
7.	

.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

26 05 00-B. INSTALLED MOTOR TEST DATA FORM

Motor Equipment Number: _____ Date of test: _____

Equipment Driven: _____

MCC Location: _____

						Ambient temp	°F
Resistance:							
Insulation resistance phase-to-ground megohms:							
Phase A		Phase B		Phase C			
Current at Full Load:							
Phase				Current, amps			
Phase				Current, amps			
Phase				Current, amps			
Thermal Overload Device:		Manufacturer/catalog #			Amperes		
Circuit breaker (MCP) setting:							

Motor Nameplate Markings:

Mfr		Mfr Model		Frame		HP	
Volts		Phase		RPM		Service factor**	
Amps		Freq		Ambient temp rating			°C
Time rating				Design letter**			
	(NEMA 1-10.35)				(NEMA MG-1.16)		
Code letter				Insulation class			

**Required for 3-phase squirrel cage induction motors only.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

26 05 00-C. DRY TRANSFORMER TEST DATA FORM

(Note: Use Data Form for dry type transformers with voltage rating of 600 Vac or less and sizes to 167 kVA single phase and 500 kVA three phase. Use NETA Test Forms and Test Procedures for higher voltages and larger transformers.)

Equipment Tag No.: _____ Temperature Rating: _____

Description/Location: _____ Feeder size/Source: _____

Primary Voltage: _____ Secondary Voltage: _____ Winding Connection: _____

A. VISUAL INSPECTION

Transformer Inspection	Pass	Fail	Note
1. Nameplate data as specified			
2. Mechanical condition			
a. Free of dents and scratches			
b. Anchored properly			
c. Shipping brackets removed			
d. Spacing from wall per nameplate			
3. Grounding *			
a. Equipment grounding			
b. System grounding			

B. INSULATION-RESISTANCE TESTS:

Perform tests with calibrated megohmeter. Apply 1000 Vdc test voltage for 60 seconds and record readings in megohms at 30-seconds and 60-seconds intervals.

Test Group	Resistance between		30-second reading	60-second reading	Absorption Ratio Index 60-sec. / 30-sec.
Primary Winding to ground	A	GRD			
	B	GRD			
	C	GRD			
Secondary Winding to ground with * N-G Bond removed	a	GRD			
	b	GRD			
	c	GRD			
Primary Winding to Secondary Winding	A	a			
	B	b			
	C	c			

Submit resistance readings to the Construction Manager immediately after the tests that are less than the manufacturer's recommended value or less than 10-megohms. Record the Absorption Ratio Index values for future reference. Ratio must be 1.0 or greater, with infinity (∞) equal to 1.0.

Contractor Representative Certified: _____ Date _____

Owner Representative Witnessed:_____ Date _____

26 05 00-M. STARTER PANEL TEST FORM

Equipment No.: _____ Ambient room temperature: _____

Location: _____

A. MECHANICAL CHECK:

All bolted connections either bus to bus or cable to bus shall be torqued to the manufacturer's recommendations.

B. PHYSICAL TEST:

1. List any discrepancies with respect to the panel specifications:

   a. Dimensions, component layout and wiring specifications.

   b. Panel and component hardware. Panel and component hardware.

   c. Quality of Workmanship (wiring and general panel assembly).

   d. Inventory of all panel parts and documentation (operations and maintenance manual).

C. ELECTRICAL TESTS:

1. Measure insulation resistance of each bus section phase to phase and phase to ground for 1 minute using a megohmmeter at 1000 volts.

Test results (megohms)			
Phase		Phase	
A-GRD		A-B	
B-GRD		B-C	
C-GRD		C-A	

2. Set the circuit breaker or MCP in the starter unit to comply with the requirements of NEC, Article 430-52 and Table 430-152.

3. Motor overload heater elements shall be sized and installed (or adjusted if solid-state) based on the actual nameplate full load amperes of the motor connected to the starter.

D. FUNCTIONAL TEST:

Components	
Disconnect Switch	
HOA Switch - Auto	
HOA Switch - Off	
HOA Switch - Hand	

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-A. LOOP WIRING AND INSULATION RESISTANCE TEST DATA FORM

Loop No.: _____

List all wiring associated with a loop in table below. Make applicable measurements as indicated after disconnecting wiring.

Wire No.	Panel Tie	Field TB	Continuity Resistance[a]		Insulation Resistance[b]			
			Cond./ Cond.	Cond./ Shield	Shield/ Gnd.	Shield/ Cond.	Cond./ Gnd.	Shield/ Shield
A			--	(A/SH)				
B			(A/B)	--				
C			(A/C)	--				
D			(A/D)	--				
etc.								

NOTES:

a. Continuity Test. Connect ohmmeter leads between wires A and B and jumper opposite ends together. Record resistance in table. Repeat procedure between A and C, A and D, etc. Any deviation of ±2 ohms between any reading and the average of a particular run indicates a poor conductor, and corrective action shall be taken before continuing with the loop test.

b. Insulation Test. Connect one end of a 500 volt megger to the panel ground bus and the other sequentially to each completely disconnected wire and shield. Test the insulation resistance and record each reading.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-D. PANEL INDICATOR CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____

Scale: _____ Range: _____

PV Scale Calibration

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-F. SIGNAL TRIP CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____

Scale: _____ Range: _____

Set Point(s): _____

After setting set point(s), run signal input through entire range and calculate deadband.

Set Point	Incr. Input Trip Point	Decr. Input Trip Point	Calc. Deadband	Required Deadband

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-G. FIELD SWITCH CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No: _____

Input: _____

Range: _____

Set Point(s): _____

Simulate process variable (flow, pressure, temperature, etc.) and set desired set point(s). Run through entire range of switch and calculate deadband.

Set Point	Incr. Input Trip Point	Decr. Input Trip Point	Calc. Deadband	Required Deadband

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-H. TRANSMITTER CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____

Output: _____

Range: _____ Scale: _____

Simulate process variable (flow, pressure, temperature, etc.) and measure output with appropriate meter.

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-I. MISCELLANEOUS INSTRUMENT CALIBRATION TEST DATA FORM

(For instruments not covered by any of the preceding test forms, the Contractor shall create a form containing all necessary information and calibration procedures.)

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-J. INDIVIDUAL LOOP TEST DATA FORM

Loop No.: _____

Description: (Give complete description of loop's function using tag numbers where appropriate.)

P&ID No.: (Attach copy of P&ID.)

a. Wiring tested:

(Attach test form 40 61 13-A)

b. Not used.

c. Instruments calibrated:

(Attach test forms 40 61 13-C through I)

d. List step-by-step procedures for testing loop parameters. Test loop with instruments, including transmitters and control valves, connected and functioning. If it is not possible to produce a real process variable, then a simulated signal may be used with the Construction Manager's approval.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-K. LOOP COMMISSIONING TEST DATA FORM

Loop No.: _____

a. Loop tested:

(Attach test form 40 61 13-J)

b. Controlled or connected equipment tests confirmed:

c. Give complete description of loop's interface with process.

d. With associated equipment and process in operation, provide annotated chart trace of loop response to changes in set points for verification of performance. This chart should demonstrate 1/4-amplitude damping as output adjusts to set point change. Show set points, starting and finishing times on chart, as well as any other pertinent data.

Connect 2-pen recorder to process variable (PV) and to controller output. Use 1 inch/second chart speed.

Pen 1 - PV - Connections:

Pen 2 - Output - Connections:

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-L. TELEMETRY PLC CONTROL PANEL TEST FORM

Location: _____

A. PHYSICAL TEST:

1. List any discrepancies with respect to the panel specifications:

a. Dimensions, component layout and wiring specifications.

b. Panel and component hardware. Panel and component hardware.

c. Quality of Workmanship (wiring and general panel assembly).

d. Inventory of all panel parts and documentation (operations and maintenance manual).

B. FUNCTIONAL TEST:

Discrete Inputs	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	

Discrete Outputs	
1	
2	
3	

4	
5	
6	
7	
8	
9	
10	
11	
12	

Analog Inputs	
Loop Powered	
Loop Powered	
Self Powered	
Self Powered	

Analog Outputs	
Loop Powered	
Loop Powered	

Power	
24 VDC Power	
12 VDC Power	
PS Fail Relay	
GFI	
Radio Power	
Touchscreen	

Comments: _____

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-M. TELEMETRY RADIO TEST FORM

Location: _____

Radio Model Number: _____

A. PHYSICAL TEST:

1. Reflected Power:
2. Radio System Address:
3. RSSI reading (Remote):
4. Mode:
5. Long Polling (Master), Buff = OnData
6. Interface Parameters:
   a. Baud Rate:
   b. Data Bits:
   c. Parity:
7. Quality of Workmanship – Antenna/Cable assembly:

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

43 05 11-A. MANUFACTURER'S INSTALLATION CERTIFICATION FORM

Contract No:	Specification section:
Equipment name:	
Contractor:	
Manufacturer of equipment item:	

The undersigned manufacturer of the equipment item described above hereby certifies that he has checked the installation of the equipment and that the equipment, as specified in the project manual, has been provided in accordance with the manufacturer's recommendations, and that the trial operation of the equipment item has been satisfactory.

Comments:

Manufacturer	Contractor
Signature of Authorized Representative	Signature of Authorized Representative
Date	Date

43 05 11-B. MANUFACTURER'S INSTRUCTION CERTIFICATION FORM

Contract No:	Specification Section:
Equipment name:	
Contractor:	
Manufacturer of equipment item:	

The undersigned manufacturer certifies that a service engineer has instructed the wastewater treatment plant operating personnel in the proper maintenance and operation of the equipment designated herein.

Operations Check List (check appropriate spaces)	
Start-up procedure reviewed	
Shutdown procedure reviewed	
Normal operation procedure reviewed	
Others:	

Maintenance Check List (check appropriate spaces)	
Described normal oil changes (frequency)	
Described special tools required	
Described normal items to be reviewed for wear	
Described preventive maintenance instructions	
Described greasing frequency	
Others:	

Manufacturer	Signature of Contractor Representative Date
Signature of Authorized Representative	
Date	Signature of Authorized Representative Date

43 05 11-C. UNIT RESPONSIBILITY CERTIFICATION FORM

LECHEE WATER SYSTEM IMPROVEMENTS PROJECT

CERTIFICATE OF UNIT RESPONSIBILITY

FOR SPECIFICATION SECTION _____

In accordance with Section 43 05 11-1.02 Unit Responsibility of the contract documents, the undersigned manufacturer of driven equipment ("manufacturer") accepts unit responsibility for all components of equipment furnished to the Project under specification Section_____ , and for related equipment manufactured under the following sections (if applicable):

[A]

[B]

[C]

[D]

[E]

[F]

[G]

We have reviewed the requirements for sections 43 05 11 and 43 23 03 where applicable) and all sections referencing this (these) section(s), including but not limited to drivers, supports for driving and driven equipment and all other specified appurtenances to be furnished to the Project by manufacturer. And, we have further reviewed, and modified as necessary, the requirements for associated variable speed drives and motor control centers. We hereby certify that all specified components are compatible and comprise a functional unit suitable for the specified performance and design requirements whether or not the equipment was furnished by us. We will make no claim nor establish any condition that problems in operation for the product provided under this specification Section _____ are due to incompatibility of any components covered by this Certificate of Unit Responsibility. Nor will we condition or void any warranty for the performance of the product of this specification Section _____ due to incompatibility of any components covered under this Certificate of Unit Responsibility.

Our signature on this Certificate of Unit Responsibility does not obligate us to take responsibility for, nor to warrant the workmanship, quality, or performance of related equipment provided by others under specification sections _____, _____, and _____. Our obligation to warranty all equipment provided by us shall remain unaffected.

Notary Public	Name of Corporation
Commission expiration date	Address
Seal:	By:
	Duly Authorized Official
	Legal Title of Official
	Date

43 05 13-A. RIGID EQUIPMENT MOUNT INSTALLATION CHECKLIST

NAVAJO NATION DEPARTMENT OF WATER RESOURCES – WATER MANAGEMENT BRANCH, WESTERN NAVAJO PIPELINE PHASE 1 LECHEE WATER SYSTEM IMPROVEMENTS (WSI)

Equipment Tag No.: _____ Date: _____

Grout Product Name and Type: _____

Grouting System Manufacturer: _____

Grouting Application Contractor: _____

General Contractor: _____

Step 1: Verify Equipment Anchor Installation Conformance to Equipment Pad Details		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Millwright		Date
Step 2: Completion of Cleaning and Concrete Substrate Preparation Prior to Grouting		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 3: Equipment Leveling		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Millwright		Date
Step 4: Installation of Protection of Adjacent Surfaces or Structures NOT TO BE GROUTED		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 5: Preparation and Construction of Forms and Epoxy Grout Filling Standpipes		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 6: Completion of Ambient Condition Control in Structure or Building Area and Acceptance of Ambient Conditions as They Apply to Application and Curing Requirements for the Grouting System		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 7: Epoxy Grout Installation		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 8: Completion of Full and Proper Cure of Epoxy Grout		
Name: Contractor Rep.		Date
Name: Construction Manager		Date

Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 9: Completion of Localized Repair of Grout Voids		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 10: Final Acceptance of Grouting System Installation Including Final Clean-Up of the Work Site Complying with All Specification Requirements and the GSM's Quality Requirements		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date

43 05 21-A. MOTOR DATA FORM

Equipment Name: _____ Equipment No(s): _____

Project Site Location: _____

Nameplate Markings

Mfr:		Mfr Model:		Frame:		Horsepower:	
Volts:		Phase:		RPM:		Service Factor:	
FLA:		LRA:		Frequency:		Amb Temp Rating:	ºC

Time rating:		Design Letter:	
	(NEMA MG1-10.35)		(NEMA MG-1.16)
KVA Code Letter:		Insulation Class:	

The following information is required for explosion-proof motors only:

A. Approved by UL for installation in Class _____, Div _____, Group _____
B. UL frame temperature code ____ (NEC Tables 500-8B)

The following information is required for all motors 1/2 horsepower and larger:

A. Guaranteed minimum efficiency _____

(Section 43 05 21-2.04 Motor Efficiency)

B. Nameplate or nominal efficiency _____

Data Not Necessarily Marked on Nameplate

Type of Enclosure:			Enclosure Material:		
Temp Rise:		ºC (NEMA MG1-12.41,42)			
Space Heater included?	☐ Yes	☐ No	If Yes:	Watts	Volts
Type of motor winding over-temperature protection, if specified:					

Provide information on other motor features specified:

_____

SECTION 02 01 20

PROTECTING EXISTING UNDERGROUND UTILITIES

PART 1 GENERAL

1.01 DESCRIPTION:

A. Protecting existing underground utilities: This section specifies the requirements for coordinating and sequencing the work with existing utilities, and requirements regarding existing site utilities protection.

B. Conditions.
   1. Contact the Arizona and NTUA one-call system for utility locations before starting work.
   2. Permit utility companies to repair or replace their lines in the project limits.
   3. Compaction.
   4. Alternative support methods.
   5. Protecting thrust blocks.

1.02 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00
   1. Record drawings to include record survey coordinates and elevations.
   2. Proposed locations for test pits.

1.03 PROJECT/SITE CONDITIONS:

A. Pipelines will be indicated on the drawings, but the right is reserved to the Owner, acting through the Construction Manager, to make such modifications in location as may be found desirable to avoid interference with existing utilities.

PART 2 PRODUCTS

2.01 MATERIALS:

A. Except as indicated, or as specifically authorized by the Construction Manager, where existing utilities to remain must be removed, reconstruct utilities with new material of the same size, type, and quality as that removed.

PART 3 EXECUTION

3.01 EXAMINATION:

A. Comply with the requirements in Section 01 12 16 Work Sequence.

B. Notify Construction Manager at least 72 hours before digging operations are scheduled to begin.

C. Test Pits: Excavate test pits to field verify the locations, depth of bury, diameter, and pipe material of existing underground utilities at crossings and at tie-in points before ordering materials or commencing excavation. Immediately notify the Construction Manager if conflicts are encountered.

3.02 PREPARATION:

A. Where utilities are parallel to or cross work, but do not conflict with work, notify the utility owner at least 48 hours in advance of construction at the crossing. Coordinate the construction schedule with the utility owner.

3.03 PROCEDURES:

A. Protect in Place: Protect existing utilities in place, unless abandoned, and maintain the utility in service, unless otherwise indicated or specified.

B. Damage to Utilities to Remain: If existing utilities to remain are damaged, immediately notify utility owner, and repair to utility owner's satisfaction.

3.04 COMPACTION:

A. Protecting Existing Utilities:
   1. Backfill and compact under and around utilities. Compaction shall conform to Section 31 21 33 Trenching backfilling and Compacting for Utilities.
   2. Where compaction cannot adequately be performed around utility due to the presence of encroaching existing utilities, utilize flowable fill. Flowable fill shall meet the requirements of NTUA. Submittals shall provide product data, test results, and all documentation as required by the Engineer to demonstrate compliance.

3.05 PROTECTION OF THRUST BLOCKS:

A. Protect thrust blocks on existing waterlines or sewer force mains in place or shore to resist the thrust by a means accepted by the Engineer and reconstruct. If the thrust blocks are exposed or rendered to be ineffective in the opinion of the Engineer, reconstruct them to bear against firm unexcavated or backfill material.
   1. Provide firm support by backfilling affected portion of the trench for a distance of 2 feet on each side of the thrust block to be reconstructed from the pipe bedding to the pavement subgrade with flowable fill. Submittals shall provide product data, test results, and all documentation as required by NTUA Standards to demonstrate compliance.
   2. Excavate the backfill material for construction of the thrust block.
   3. Test compaction of the backfill material before pouring any concrete thrust block.

END OF SECTION

SECTION 02 41 13

DEMOLITION AND SALVAGE

PART 1 GENERAL

1.01 SUMMARY

A. This section includes materials and equipment to be salvaged and returned to the Owner; or demolished and removed from the site as trash by the Contractor. The sequence in which systems can be worked on shall be as specified in Section 01 12 16.

1.02 SCOPE OF WORK

A. Furnish all labor, material, equipment, and incidentals required to demolish, modify, or alter existing facilities as shown or specified and as required for the installation of new mechanical equipment, piping, architectural features and appurtenances. Existing piping and equipment shall be removed and dismantled as necessary for the performance of structural, architectural, and piping alterations in accordance with the requirements herein specified.

B. Coordinate with the subcontractor and Owner for all materials required to be turned over to Owner.

1.03 EXISTING CONDITIONS

A. Contractor shall visit the site and inspect the nature and condition of all facilities to be demolished, partially demolished, modified, or altered in any way prior to submittal of his Bid. No increase in cost or extension of Contract time will be considered for failure to know the conditions of the site and structures.

1.04 SALVAGE

A. Any items specifically indicated to be reused or designated to be salvaged for Owner's own purposes shall be carefully removed, and be relocated to designated storage areas on the project site. Contractor shall protect salvaged equipment and materials from weather, staining, construction damage, theft, and vandalism. Arrange storage to facilitate inspection by Construction Manager.

B. The Contractor shall notify the Construction Manager 15 days prior to commencement of demolition work in an area. The Owner shall then tag equipment, piping, valves, control devices, electrical, etc. with a color-code system to designate the location for salvaged items to be stored.

C. The Contractor shall provide four colors of wire tags similar to EMED Co., Inc., LMT70 with a quantity of 2,000 for each color.

1.05 DEMOLITION AND DISPOSAL

A. All other materials removed under the demolition work, including dismantled equipment and materials, piping, pumps, fittings, valves, machinery, gates, concrete equipment pads, miscellaneous and structural metals, masonry, and other construction debris shall become the property of the Contractor and be removed from the site as trash. Trash and debris shall be disposed of legally, off the site, by Contractor. Upon removal from site, Contractor shall have the rights of salvage of materials. The salvage value of any materials removed in accordance with this paragraph shall be considered by the Contractor when determining a bid price for demolition.

1.06 PROTECTION OF EXISTING FACILITIES

A. The Contractor shall diligently protect existing structures and property of the Owner while proceeding with work of this section and the entire Contract. All damage shall be repaired at once to the satisfaction of the Owner. All such repairs shall be at the expense of the Contractor and no claims for additional payment will be accepted.

B. When removing materials or portions of existing structures and when making openings in walls and partitions, the Contractor shall provide barriers, dust screens, and other protective devices so as not to damage the structures beyond the limits necessary for the new work, nor to damage the structures or contents by falling or flying debris nor to transfer any heavy shocks and vibrations to structures to remain. Swinging weights shall not be used to demolish structures.

PART 2 PRODUCTS

2.01 REPAIR AND RESTORATION

A. The Contractor shall alter or rework existing structures as shown and specified. Generally, when items of equipment and piping are removed, the areas and surfaces from which items were removed shall be left with a neat appearance and finish compatible with surrounding areas, colors, and surfaces. The Contractor shall do all painting, sanding, grouting, sacking, resurfacing, and other Work as necessary to comply with the above requirements. Prior to structural modifications, all surfaces shall be subject to inspection by the Construction Manager. Colors shall match existing colors as closely as possible. For replacement, repair of restoration of work removed, comply with the Specifications for the type of work to be done.

2.02 PENETRATIONS

A. Where holes in existing masonry or concrete are required to be sealed, unless otherwise specified, they shall be sealed with cement mortar or concrete. The sides of the openings shall be provided with keyed joints and shall be suitably roughened to furnish a good bond and make a watertight joint. All loose or unsound material adjacent to the opening shall be removed and, if necessary, replaced with new material. The method of placing the mortar seal shall provide a suitable means of releasing entrapped air.

2.03 MODIFICATIONS OF EXISTING STRUCTURES

A. Where only a portion of the existing structure is to be removed, the existing concrete shall be sawed to neat lines as shown on the plans or as established by the Construction Manager. Reinforcing steel shall be removed to a depth of 2 inches from the finished surface. Anchor bolts for equipment and structural steel removed shall be cut off 1-inch below the concrete surface. Surface shall be finished as specified in Division 3.

B. When connections are to be made to existing concrete structures, the existing reinforcing steel shall be exposed to a depth of 12 inches and all bars spliced to the new reinforcing steel.

2.04 PIPING MODIFICATIONS

A. Where necessary or required for the purpose of making piping connections, cut existing pipelines and provide suitable plugs, bulkheads, or other means to hold back the flow of water or other liquids, all as required in the performance of the work under this Contract. The remaining open ends of all piping, valves, fittings, and appurtenances that are removed shall be plugged with standard pipe plugs or closed with flanges so that there will be no leakage through the closure.

PART 3 EXECUTION

3.01 CONTROL OF HAZARDOUS AND NUISANCE CONDITIONS

A. All demolition, salvage, and renovation work shall be conducted in a manner which will protect the environment, promote public health and safety, and preclude nuisance conditions., in strict conformance with the requirements of Section 01 11 80. In addition, Contractor shall enforce the following safety requirements:
   1. No fires will be permitted on-site.
   2. Post "No Smoking" signs in all interior spaces and in hazardous or confined spaces where dismantling operations are to be carried on. Strictly enforce "No Smoking" restrictions among all personnel employed on the work.

3.02 DEMOLITION OF EXISTING STRUCTURES

A. Structures that are in the way of new construction shall be removed completely, regardless if they are above or below existing or proposed ground or grade. This work may be done in any manner selected by the Contractor, and reviewed by the Construction Manager, that does not endanger adjacent structures and property. The use of explosives will not be permitted for any purposes.

B. Structural steel members shall be cut into sections of such weight and size as will permit convenient handling, hauling, and storage. Concrete to be demolished and removed shall be broken into pieces not greater than 24 inches in any dimension by methods reviewed by the Construction Manager.

3.03 GRADING AND BACKFILL

A. All excavation made in connection with this item and all openings below permanent ground caused by the removal of a structure shall be backfilled with suitable material and graded to match the proposed grading plan. That portion of the backfill which will support any portion of a roadbed, driveway, or structure shall be backfilled and compacted in accordance with applicable Specification sections for Earthwork and Paving.

3.04 WEATHER PROTECTION: NOT USED

3.05 EXISTING TREES

A. Extreme care should be taken when working around existing trees. No excavation or compaction shall take place within the tree drip line except with prior permission of the Owner or where the tree is shown for removal on the Drawings.

3.06 ITEMS TO BE SALVAGED AND RETURNED TO OWNER – NOT USED

END OF SECTION

SECTION 02 90 00

REVEGETATION

PART 1 GENERAL

1.01 THE REQUIREMENT

A. The CONTRACTOR shall provide erosion protection including fertilizing, seeding, and mulching for all disturbed areas.

B. The CONTRACTOR shall provide biodegradable erosion control blanket on all slopes greater than 4H:1V.

1.02 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01 33-00 – Submittal Procedures.

B. Product Data: Manufacturer's catalog sheets and sample of erosion control fabrics.

PART 2 PRODUCTS

2.01 MATERIALS

A. Fertilizer: Fertilizer shall be a commercial, chemical type, uniform in composition, free-flowing, conforming to state and federal laws and suitable for application with equipment designed for that purpose. Fertilizer shall have a guaranteed analysis showing not less than 11 percent nitrogen, 8 percent available phosphoric acid, and 4 percent water soluble potash.

B. Seed: Seed shall be delivered in original unopened packages bearing an analysis of the contents. Seed shall be guaranteed 95 percent pure with a minimum germination rate of 80 percent. Seed mix shall be native vegetation consisting of 3 lb – Crested Wheatgrass, 1 lb – Pubescent Wheatgrass, 2 lb – Indian Ricegrass, 3 lb – Western Wheatgrass, and 2 lb – 4-wing Salt bush.

C. Mulch: Mulch shall be a fibrous, wood cellulose product produced for this purpose. It shall be dyed green and shall contain no growth or germination inhibiting substances and shall be manufactured so that when thoroughly mixed with seed, fertilizer, and water, in the proportions indicated it will form a homogenous slurry which is capable of being sprayed. The mulch shall be Sliva Fiber as manufactured by Weyerhaeuser Company; Conwood Fiber as manufactured by Consolidated Wood Conversion Corp.; or equal.

D. Erosion Control Fabric
   1. Materials: North American Green, S75 Temporary Erosion Control Blanket, or equal.
   2. Anchorage Devices: Six-inch, 11-gauge staples from the manufacturer or staples of the proper length as recommended by the manufacturer for specific soil condition.

E. Manufacturers, or Equal
   1. North American Green
   2. Mirafi (Ten Cate)
   3. Maccaferri

PART 3 EXECUTION

3.01 GENERAL

A. Weather Conditions: Fertilizing, seeding, or mulching operations will not be permitted when wind velocities exceed 15 miles per hour or when the ground is frozen, unduly wet, or otherwise not in a tillable condition.

B. Soil Preparation: The ground to be seeded shall be graded in conformance with the Drawings and shall be loose and reasonably free of large rocks, roots, and other material which will interfere with the work.

C. Method of Application: Fertilizer, seed, and mulch may be applied separately (Dry Method), or they may be mixed together with water and the homogeneous slurry applied by spraying (Hydraulic Method), except that all slopes steeper than 3H:1V shall be stabilized by the Hydraulic Method.

3.02 DRY METHOD

A. Fertilizing: The fertilizer shall be spread uniformly at the rate of 800 lb per acre (approximately 1 lb per 55 square feet). The fertilizer shall be raked in and thoroughly mixed with the soil to a depth of approximately 2-inches prior to the application of seed or mulch.

B. Seeding: The seed shall be broadcast uniformly at the rate of 16.5 lb per acre. After the seed has been distributed it shall be incorporated into the soil by raking or by other approved methods.

C. Mulch Application: Mulch shall be applied at the rate of 1,500 lb (air dried weight) per acre.

3.03 HYDRAULIC METHOD

A. The hydraulic method consists of the uniform application by spraying of a homogeneous mixture of water, seed, fertilizer, and mulch. The slurry shall be prepared by mixing the ingredients in the same proportions as indicated above. The slurry shall have the proper consistency to adhere to the earth slopes without lumping or running. Mixing time of materials shall not exceed 45 minutes from the time the seeds come into contact with the water in the mixer to the complete discharge of the slurry onto the slopes, otherwise the batch shall be recharged with seed. The mixture shall be applied using equipment containing a tank having a built-in, continuous agitation and recirculation system, and a discharge system which will allow application of the slurry to the slopes at a continuous and uniform rate. The application rates of the ingredients shall be the same as those specified for the Dry Method. The nozzle shall produce a spray that does not concentrate the slurry nor erode the soil.

3.04 EROSION CONTROL BLANKET

A. Placement
   1. Biodegradable erosion control blanket shall be used on all slopes 4H:1V and steeper.
   2. The erosion control shall be spread only on prepared, fertilized, and seeded surfaces.
   3. On all slopes, the erosion control blanket shall be laid up-and-down the slope in the direction of water flow.
   4. Waste of erosion control material shall be minimized by limiting overlaps as specified and by utilizing the full length of the netting at roll ends.

B. Anchorage
   1. Ends and sides of adjoining pieces of material shall be overlapped 6-inches and 4-inches respectively, and stapled. Six anchors shall be installed across ends. A common row of staples shall be used at side joints. Staple through both blankets, placing staples approximately 6-inches apart.
   2. The top edge of the erosion control blanket shall be anchored in a 6-inch deep by 6-inch-wide trench. Backfill and compact trench after stapling.
   3. Anchorage shall be by means of 9-inch long, 2-legged staples driven vertically and full-length into the ground. The legs shall be spread 3-inches to 4-inches apart at the ground to improve resistance to pull-out. In loose soils the use of 18-inch metal washer pins may be required to properly anchor the blankets.
   4. All slopes which are 3:1 or greater shall be stapled with 2 staples per square yard in a triangular pattern. Staples shall be installed per the manufacturer's recommended staple pattern guide.
   5. The erosion control blanket shall not be stretched but should be laid loosely over the ground to avoid pulling the blanket downslope.
   6. The erosion control blanket shall not be rolled out onto ground containing frost within the 9-inch penetration zone of the anchorage staples. Further, no stapling shall be undertaken while any frost exists within the staple penetration zone.

3.05 WATERING

A. Upon completion of the erosion control seeding, water shall be applied as specified by the seed manufacture to meet germination requirements.

3.06 MAINTENANCE PRIOR TO FINAL ACCEPTANCE

A. The CONTRACTOR shall maintain the planted areas in a satisfactory condition until final acceptance of the project. Such maintenance shall include the filling, leveling, and repairing of any washed or eroded areas, as may be necessary, and sufficient watering to maintain the plant materials in a healthy condition. The ENGINEER may require replanting of any areas in which the establishment of the vegetative ground cover does not appear to be developing satisfactorily.

END OF SECTION

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SECTION 03 11 00

CONCRETE FORMING

PART 1 GENERAL

1.01 DESCRIPTION

A. Formwork requirements for concrete construction.

1.02 QUALITY ASSURANCE

A. References:

1. The references listed below are part of this section. Where a referenced document cites other standards, such standards are included as references under this section as if referenced directly. In the event of conflict, the requirements of this section shall prevail.

Reference	Title
ACI 117	Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures
ACI 350.5	Specifications for Environmental Concrete Structures
National Institute of Standards - PS1	Construction and Industrial Plywood

B. Design – General:

1. Provide design of formwork, shoring and reshoring systems by the Contractor's Professional Engineer currently registered in the State of Arizona.
2. Design, engineering, and construction of formwork, shoring, and reshoring systems is the responsibility of the Contractor.
3. Develop a procedure and schedule for removal of shores (and installation of reshores).
4. Structural record calculations, signed and sealed by the Contractor's Engineer, are required to prove that all portions of the structure, in combination with the remaining forming and shoring systems, have sufficient strength to safely support their own weight plus the loads placed thereon.
5. When developing procedures, schedules, and structural calculations; consider the structural system that exists, effects of imposed loads, and the strength of concrete at each stage of construction.

C. Design Criteria:

1. Design formwork in accordance with ACI 301 and ACI 318 for building structures and ACI 350 and 350.5 for environmental structures to provide concrete finishes as specified in Section 03 30 00.
2. Design systems for full height of wet concrete pressure.
3. Design formwork to limit maximum deflection of form facing materials, as reflected in concrete surfaces exposed to view, to 1/240 of span.

1.03 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Manufacturer's product data with installation instructions:
      a. Form materials.
      b. Form ties (with waterstops).
      c. Form release compound.
      d. Void forms.

B. Informational Submittals:
   1. Procedures: Section 01 33 00.
   2. Letter of certification:
      a. Stating that formwork has been designed in accordance with this specification and referenced documents, sealed and stamped by the Contractor's registered design Engineer.

PART 2 PRODUCTS

2.01 FORMS

A. Wood Forms:
   1. Provide new and unused exterior grade plywood panels manufactured in accordance with American Plywood Association (APA) and bearing the trademark of that group.
      a. Forms for concrete surfaces exposed to view: use APA High Density Overlay (HDO) Plyform Class I Exterior 48" X 96" X 3/4".
      b. Forms for other concrete surfaces: use APA Douglas Fir B-B Plyform Class I Exterior 48" X 96" X 3/4-inch.
   2. When approved, plywood may be reused.

B. Metal Forms:
   1. Do not use aluminum. Provide forms free of rust and straight without dents to provide members of uniform thickness.

2.02 FORM TIES

A. Commercially fabricated for use in form construction. Fabricated so that ends or end fasteners can be removed without causing spalling at surfaces of the concrete. Cone on ends shall be 3/4 inch to 1 inch diameter. Provide embedded portion of tie not less than 1 1/2 inch from face of concrete after cone ends have been removed. Provide ties with integral waterstops at water-retaining and below grade structures.

B. Tapered through-bolts may be used when approved. Use 1-inch minimum diameter at the smallest end. Fill tapered tie holes after cleaning to produce watertight construction. Use a mechanical waterstop plug near the center of the wall and fill each side with non-shrink cement grout. Mechanical waterstop plug shall be Greenstreak Group, Inc. "X-Plug"; or equal.

2.03 FORM RELEASE COMPOUND

A. Coat form surfaces in contact with concrete using a non-staining, non-residual, water based, bond-breaking form coating. Use NSF approved form release agents in potable water containment structures.

PART 3 EXECUTION

3.01 PREPARATION

A. Cover surface of forms with form release compound prior to form installation in accordance with manufacturer's recommendations.

B. Do not permit excess form coating material to stand in puddles on forms or hardened concrete surfaces against which fresh concrete is to be placed.

C. Clean surfaces of forms, reinforcing steel and other embedded items of accumulated mortar, grout, or other foregn materials from previous concreting or construction activities before concrete is placed.

3.02 FORMWORK CONSTRUCTION

A. Form vertical surfaces of cast-in-place concrete including sides of footings.

B. Construct and place forms so that the resulting concrete will be of the shape, lines, dimensions, and appearance indicated on the Drawings. Brace or tie forms together to maintain position and shape under the load of freshly-placed concrete.

C. Tighten forms to prevent leakage.

D. Provide temporary openings (windows) at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed.

E. Provide temporary openings to limit height of free fall of concrete and to limit the lateral movement of concrete during placement. Openings are required in wall placements greater than 20 feet in height, spaced no more than 8 feet on center measured horizontally and vertically.

F. Place a 3/4-inch chamfer strip at exposed to view corners of formed surfaces.

G. At construction joints,overlap hardened concrete surface by at least 1 inch. Brace forms against hardened concrete to prevent movement, offsets, or loss of mortar at construction joint and to maintain a true surface. Where possible, locate juncture of built-in-place forms at architectural lines, control joints, or at other inconspicuous lines.

H. Construct wood forms for openings to facilitate loosening. Anchor forms so that movement of any part of the formwork system is prevented during concrete placement.

I. At platforms constructed to move equipment over in-place reinforcment, provid beams, struts, and/or legs, supported directly on formwork or other structural members without resting on reinforcing steel.

J. Provide a positive means of adjustment (wedges or jacks) at shores and struts to take up settlement during concrete placement. Brace forms against lateral deflection. Fasten in-place wedges and shims used for final adjustment of forms prior to concrete placement.

K. Place tapered through-bolt form ties with the larger end on the side of the structure in contact with liquid.

3.03 TOLERANCES

A. Install formwork with tolerances in accordance with ACI 117 and the following (the more stringent requirement controls):

1. Install formwork in accordance with manufacturer's written instructions.
2. Vertical surface tolerance from plumb; walls, columns, piers, and risers:
   ± 1/2 inch for entire height
   ± 1/4 inch in any 10 feet of height
3. Vertical surface tolerance from plumb; exposed wall corners, end columns, control-joint grooves, and other exposed to view vertical lines:
   ± 1/2 inch for entire height
   ± 1/4 inch in any 20 feet of height
4. Horizontal variation from level or from grade; top of slabs, slab soffits, ceilings, and beam soffits, measured before removal of supporting shores:
   ± 3/4 inch for entire length
   ± 3/8 inch for any bay or 20 foot length
   ± 1/4 inch in any 10 feet of length
5. Horizontal variation from level or from grade; exposed lintels, sills, parapets, horizontal grooves, and other exposed-to-view horizontal lines:
   ± 1/2 inch for entire length
   ± 1/4 inch in any 20 feet of length.
6. Plan position variation; columns, walls, and partitions:
   ± 3/4 inch for entire length
   ± 3/8 inch for any bay or 20 foot length
7. Plan location and size; sleeves, floor openings, walls, wall openings, beams, and columns:
   ± 1/2 inch
8. Cross sectional dimensions; columns and beams and thickness of slabs and walls:
   ± 3/8 inch
9. Plan dimensions; footings and foundations:
   minus 1/2 inch
   + 2 inches
10. Misplacement or eccentricity; footings and foundations:
    2 percent of footing width in direction of misplacement
    not more than 2 inches
11. Thickness; footings and foundations:
    minus 5 percent
    no limit on the maximum increase except that which may interfere with other construction.

12. Step variance in flight of stairs:
    Rise ± 1/16 inch
    Tread from level ± 1/8 inch

B. Use control points and benchmarks for reference purposes to check tolerances. Establish and maintain reference points in an undisturbed condition until final completion and acceptance of the work.

C. Regardless of tolerances listed, no portion of a structure shall extend beyond the legal boundary of work site.

D. Camber formwork to compensate for anticipated deflections in formwork under wet load of concrete. Adjust camber to maintain above specified tolerances in hardened concrete after forms and shoring are removed.

3.04 REMOVAL OF FORMS

A. Do not impose construction loads or remove shoring from any part of the structure until that portion of the structure in combination with remaining forming and shoring systems has sufficient strength to safely support its weight and loads placed thereon.

B. If forms are loosened and not removed, proceed same day with wet curing operations to soak surfaces of concrete where forms are loosened. When wet curing is not practical or not planned, loosen, remove, and start approved curing proceedures on the same day.

C. When required for concrete curing in hot weather, required for repair of surface defects, or when required for finishing at an early age; remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support.

D. Remove top forms on sloping surfaces as soon as concrete has attained sufficient stiffness to prevent sagging. Make repairs or finishing treatment on such sloping surfaces immediately after form removal.

E. Remove wood forms for wall openings as soon as this can be accomplished without damage to concrete.

F. Remove formwork from columns, walls, sides of beams, and other parts not supporting weight of concrete as soon as concrete has hardened sufficiently to resist damage from removal.

G. When shores and supports are so arranged such that non-load-carrying form facing material can be removed without loosening or disturbing other shores and supports, facing material may be removed when concrete has sufficiently hardened to resist damage from removal.

H. In all cases, proceed with curing same day as form removal.

I. Where no reshoring is planned, forms and shoring used to support weight of concrete shall be left in place until concrete has attained its specified 28-day compressive strength.

3.05 RESHORING

A. Do not impose construction loads or remove shoring from any part of the structure until that portion of the structure, in combination with remaining forming and shoring systems, has sufficient strength to safely support its weight and loads placed thereon.

B. While reshoring is underway, no superimposed dead or live loads are permitted on the new construction.

C. During reshoring, do not subject concrete in structural members to combined dead and construction loads in excess of loads that the structural members can adequately support.

D. Place reshores as soon as practicable after stripping operations are complete, but in no case later than the end of working day on which stripping occurs.

E. Place reshores to carry their required loads without overstressing.

F. Where a reshoring procedure is planned, supporting formwork may be removed when concrete has reached the concrete strength specified by the formwork engineer's structural calculations and verified by field cured test cylinders or other approved method.

END OF SECTION

SECTION 03 20 00

CONCRETE REINFORCING

PART 1 GENERAL

1.01 DESCRIPTION

A. Section includes: Reinforcing steel for use in reinforced concrete.

1.02 REFERENCES:

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ACI 117	Specification for Tolerances for Concrete Construction and Materials
ACI 315	Details and Detailing of Concrete Reinforcement
ACI 318	Building Code Requirements For Structural Concrete
ACI SP-66	ACI Detailing Manual
ASTM A615	Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706	Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A775	Epoxy-Coated Steel Reinforcing Bars
ASTM A884	Epoxy-Coated Steel Wire and Welded Wire Reinforcement
ASTM A1064	Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
AWS D1.4	Structural Welding Code - Reinforcing Steel
CRSI-PRB	Placing Reinforcing Bars
CRSI-MSP	Manual of Standard Practice
FEDSPEC QQ-W-461H	Wire, Steel, Carbon (Round, Bare, and Coated)

1.03 SUBMITTALS

A. Action Submittals
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. Mill certificates of mill analysis, tensile, and bend tests for all reinforcing.

5. Manufacturer and type of proprietary reinforcing steel splices. Submit a current ICC Report and manufacturer's literature that contains instructions and recommendations for each type of coupler used.
6. Qualifications of welding operators, welding processes and procedures.
7. Reinforcing steel shop drawings showing reinforcing steel bar quantities, sizes, spacing, dimensions, configurations, locations, mark numbers, lap splice lengths and locations, concrete cover and reinforcing steel supports. Reinforcing steel shop drawings shall be of sufficient detail to permit installation of reinforcing steel without reference to the contract drawings. Shop drawings shall not be prepared by reproducing the plans and details indicated on the contract drawings but shall consist of completely redrawn plans and details as necessary to indicate complete fabrication and installation of reinforcing steel, including large scale drawings at joints detailing bar placement in congested areas. Placement drawings shall be in accordance with ACI 315. Reinforcing details shall be in accordance with ACI SP-66.

1.04 DELIVERY, STORAGE AND HANDLING

A. Ship reinforcing steel to the jobsite with attached plastic or metal tags having permanent mark numbers which match the shop drawing mark numbers. All reinforcing shall be supported and stored above ground. Use only plastic tags secured to the reinforcing steel bars with nylon or plastic tags for epoxy coated reinforcing steel bars.

PART 2 PRODUCTS

2.01 BAR REINFORCEMENT

A. Reinforcing steel bars shall be deformed billet steel in conformance with ASTM A615, Grade 60. Bars to be welded shall be deformed billet steel conforming to ASTM A706. Where specified, reinforcing steel shall be epoxy-coated in conformance with ASTM A775.

2.02 WIRE FABRIC

A. Wire fabric shall be welded steel mesh conforming to ASTM A1064.

2.03 WIRE AND PLAIN BARS

A. Wire used as reinforcement and bars used as spiral reinforcement in structures shall be cold drawn steel conforming to ASTM A1064.

2.04 SMOOTH DOWEL BARS

A. Smooth dowel bars shall conform to ASTM A615, Grade 60, with a metal end cap at the greased or sliding end to allow longitudinal movement.

2.05 REINFORCING STEEL MECHANICAL SPLICES

A. Reinforcing steel mechanical splices shall be a positive connecting threaded type mechanical splice system manufactured by Erico, Inc., Dayton Superior, Williams Form Engineering Company, or approved equal.

B. Type 1 mechanical splices shall develop in tension or compression a strength of not less than 125 percent of the ASTM specified minimum yield strength of the reinforcement and shall meet all other ACI 318 requirements. Where splices at the face of wall are shown or approved, form saver-type mechanical couplers may be used. Form-saver couplers shall have integral plates designed to positively connect coupler to formwork. Type 1 mechanical splices are typical except for locations noted below where Type 2 mechanical splices are required.

2.06 TIE WIRE

A. The wire shall be minimum 16 gage annealed steel conforming to FEDSPEC QQ-W-461H.

2.07 BAR SUPPORTS

A. Bar supports coming into contact with forms shall be CRSI Class 1 plastic protected or Class 2 stainless steel protected and shall be located in accordance with CRSI-MSP and placed in accordance with CRSI-PRB. Plastic coating on legs shall extend at least 0.5-inch upward from form surface.

B. Provide precast concrete blocks, four inches square in plan, with embedded tie wires (wire dobies) as specified by CRSI 1 MSP for footing and slabs on grade. Do not use brick, broken concrete masonry units, spalls, rocks, construction debris, or similar material for supporting reinforcing steel. Precast concrete blocks shall have same or higher compressive strength as specified for concrete in which they are located.

C. Provide stainless steel or plastic protected plain steel supports for other work.

2.08 FABRICATION:

A. Fabricate reinforcing steel bars in accordance with ACI 315 and the following tolerances:
   1. Sheared lengths: +/-1 inch.
   2. Overall dimensions of stirrups, ties, and spirals: +/-1/2 inch.
   3. All other bends: +0 inch, -1/2 inch
   4. Minimum diameter of bends of reinforcing steel bars: Per ACI 318.

PART 3 EXECUTION

3.01 PLACEMENT TOLERANCE

A. Reinforcing steel placement tolerance shall conform to the requirements of ACI 117, ACI 318, and the following:
   1. Reinforcing steel bar clear distance to formed surfaces shall be within +/-1/4 inch of specified clearance and minimum spacing between bars shall be a maximum of 1/4 inch less than specified.
   2. Reinforcing steel top bars in slabs and beams shall be placed +/-1/4 inch of specified depth in members 8 inches deep or less and -1/4", +1/2 inch of specified depth in members greater than 8 inches deep.
   3. Reinforcing steel spacing shall be placed within +/- one bar diameter or +/- 1 inch, whichever is greater.

4. The minimum clear distance between reinforcing steel bars shall be equal to the greater of 1 inch or the reinforcing steel bar diameter for beams, walls and slabs, and the greater of 1 1/2 inches or 1.5 times the reinforcing steel bar diameter for columns.
5. Beam and slab reinforcing steel bars shall be threaded through column vertical reinforcing steel bars without displacing the column reinforcing steel bars and still maintain clear distances for beam and slab reinforcing steel bars.

3.02 CONCRETE COVER

A. Unless specified otherwise on the Drawings, reinforcing steel bar cover shall conform to the following:
   1. Reinforcing steel bar cover shall be 3 inches for concrete cast against earth.
   2. Reinforcing steel bar cover shall be 2 inches for reinforcing steel bars for formed concrete surfaces exposed to earth and weather.
   3. Reinforcing steel bar cover shall be 2 inches for any formed surfaces exposed to or above any liquid.
   4. Reinforcing steel bar cover shall be 1 ½ inches for reinforcing not in the above categories unless noted otherwise on the design drawings.

3.03 SPLICING

A. Reinforcing steel splicing shall conform to the following:
   1. Use Class B splice lengths in accordance with ACI 318 for all reinforcing steel bars unless shown otherwise on the drawings.
   2. Unless noted otherwise on the Drawings, splices in circumferential reinforcement in circular walls shall be Class B tension splices and shall be staggered. Adjacent hoop reinforcement splices shall be staggered horizontally by not less than one lap length (center of lap below to center of lap above) or 3 feet, whichever is greater, and shall not coincide in vertical arrays more frequently than every third bar.
   3. Splicing of reinforcing elements noted as “tension tie” members on the Drawings shall be avoided whenever possible. If splices cannot be avoided, the splices shall be made with full mechanical or full welded splice capable of developing at least 125 percent of the specified yield strength of the bar. Splices in adjacent bars shall be staggered at least 30 inches.
   4. For welded wire fabric the splice lap length measured between the outermost cross wires of each fabric sheet shall not be less than one spacing of cross wires plus 2 inches, nor less than 1.5 times the development length nor less than 6 inches.
   5. Splices of reinforcement steel bars not specifically indicated or specified shall be subject to the approval of the Owner’s Representative. Mechanical proprietary splice connections may be used when approved by the Owner’s Representative or as indicated on the drawings.
   6. Welding of reinforcing steel bars is not allowed unless approved by the Owner’s Representative.

3.04 CLEANING

A. Reinforcing steel bars at time of concrete placement shall be free of mud, oil, loose rust, or other materials that may affect or reduce bond. Reinforcing steel bars with rust, mill

scale or a combination of both may be accepted without cleaning or brushing provided dimensions and weights including heights of deformation on a cleaned sample are not less than required by applicable ASTM standards.

3.05 PLACEMENT

A. Reinforcing steel bar placement shall conform to the following:
   1. Uncoated reinforcing steel bars shall be supported and fastened together to prevent displacement by construction loads or concrete placement. For concrete placed on ground, furnish concrete block supports or metal bar supports with non-metallic bottom plates. For concrete placed against forms furnish plastic or plastic coated metal chairs, runners, bolsters, spacers and hangers for the reinforcing steel bar support. Only tips in contact with the forms require a plastic coating.
   2. Where parallel horizontal reinforcement in beams is indicated to be placed in two or more layers, reinforcing steel bars in the upper layers shall be placed directly over the reinforcing steel bars in the bottom layer with the clear distance between each layer to be 2 inches unless otherwise noted on the Drawings. Place spacer reinforcing steel bars at a maximum of 3'-0" on center to maintain the minimum clear spacing between layers.
   3. Extend reinforcement to within 2 inches of formed edges and 3 inches of the concrete perimeter when concrete is placed against earth.
   4. Reinforcing steel bars shall not be bent after embedding in hardened concrete unless approved by the Owner's Representative.
   5. Tack welding or bending reinforcing steel bars by means of heat is prohibited.
   6. Where required by the contract documents, reinforcing steel bars shall be embedded into the hardened concrete utilizing an adhesive anchoring system specifically manufactured for that application. Installation shall be per the manufacturer's written instructions.
   7. Bars with kinks or with bends not shown shall not be used.
   8. Heating or welding bars shall be performed in accordance with AWS D1.4 and shall only be permitted where specified or approved by the Owner's Representative. Bars shall not be welded at the bend.

3.06 FIELD QUALITY CONTROL

A. Field quality control shall include the following:
   1. Notify the Owner's Representative whenever the specified clearances between the reinforcing steel bars cannot be met. The concrete shall not be placed until the Contractor submits a solution to the congestion problem and it has been approved by the Owner's Representative.
   2. The reinforcing steel bars may be moved as necessary to avoid other reinforcing steel bars, conduits or other embedded items provided the tolerance does not exceed that specified in this section. The Engineer's approval of the modified reinforcing steel arrangement is required where the specified tolerance is exceeded. No cutting of the reinforcing steel bars shall be done without written approval of the Owner's Representative.
   3. An independent laboratory shall be employed to review and approve Contractor welding procedures and qualify welders in accordance with AWS D1.4. The laboratory shall visually inspect each weld for visible defects and conduct non-destructive field

testing (radiographic or magnetic particle) on not less than one sample for each 10 welds. If a defective weld is found, the previous 5 welds by the same welder shall also be tested.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Cast-in-place concrete, which consists of providing material, mixing, transporting equipment, and labor for the proportioning, mixing, transporting, placing, consolidating, finishing, curing, and protection of concrete in the structure.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related specification sections. Additional related sections may apply that are not specifically listed below.
   1. Section 03 60 00 Grouting
   2. Section 05 50 00 Metal Fabrications
   3. Section 07 91 26 Joint Fillers
   4. Section 07 92 00 Joint Sealants
   5. Section 09 90 00 Painting and Coating

1.03 REFERENCES:

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ACI 117	Tolerances for Concrete Construction and Materials
ACI 211.1	Selecting Proportions for Normal, Heavy Weight and Mass Concrete
ACI 301	Specifications for Structural Concrete
ACI 305.1	Specification for Hot Weather Concreting
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 214R	Guide to Evaluation of Strength Test Results in Concrete
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures
ACI 350.1	Tightness Testing of Environmental Engineering Concrete Containment Structures
ACI 503.7	Crack Repair by Epoxy Injection
ASTM C31	Making and Curing Concrete Test Specimens in the Field
ASTM C33	Concrete Aggregates
ASTM C39	Compressive Strength of Cylindrical Concrete Specimens
ASTM C42	Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C94	Ready-Mixed Concrete
ASTM C117	Materials Finer Than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131	Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

Reference	Title
ASTM C136	Sieve Analysis of Fine and Coarse Aggregates
ASTM C143	Slump of Hydraulic Cement Concrete
ASTM C150	Portland Cement
ASTM C157	Length Change of Hardened Cement Mortar and Concrete
ASTM C172	Sampling Freshly Mixed Concrete
ASTM C192	Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231	Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Air-Entraining Admixtures for Concrete
ASTM C309	Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494	Chemical Admixtures for Concrete
ASTM C595	Blended Hydraulic Cements
ASTM C618	Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C881	Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989	Slag Cement for use in Concrete and Mortars
ASTM C1059	Latex Agents for Bonding Fresh to Hardened Concrete
ASTM C1260	Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1315	Liquid Membrane-Forming Compounds for Curing and Sealing Concrete
ASTM C1567	Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate
ASTM C1602	Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D75	Sampling Aggregates
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM E329	Agencies Engaged in Construction Inspection and/or Testing
CRD-C572	U.S. Corps of Engineer's Specifications for Polyvinylchloride Waterstop
IBC	International Building Code with local amendments

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined signify compliance with the specification. Include a detailed, written justification for each deviation. Failure to include a copy of this marked-up specification section, along with justification(s) for requested deviations, with the submittal, is cause for rejection of the entire submittal with no further consideration.
   4. Each proposed mix design showing:
      a. Expected strength at 7 and 28-days
      b. Slump, before and after introduction of high-range water-reducing admixture
      c. Water/cement ratio
      d. Weights and test results of the ingredients
      e. Aggregate gradation
      f. Test results of mix design prepared by an independent testing laboratory

g. Shrinkage test results for liquid containing structures
h. Other physical properties necessary to review each mix design for conformance with these specifications

5. Mix designs proposed shall be sealed by a Professional Engineer registered in the state where the project is located.
6. Product literature and technical data for aggregates, cement, and pozzolan.
7. Product literature, technical data, and dosage of proposed admixtures including, but not limited to, air entraining, water reducing, retarding, shrinkage reducing, etc.
8. Anticipated average delivery time from batch plant to site. If this time exceeds the limit specified in Part 3, include proposed method to extend set time without deleterious effects on final product. Owner's Representative reserves the right to accept or reject such proposed methods.
9. Lift Drawings: Submit shop drawings for concrete placements on the project before on-site construction begins. The drawings shall be organized by structure and submitted as a complete set for the Engineer's review. The drawings shall be drawn to scale and show dimensions, forming details, and placement volumes. Show location of construction joints, details of surface preparation, scheduled finish, embedments, penetrations, openings, keyways, blockouts, bulkheads, etc. The drawings shall clearly show the placement sequence and will be accompanied by a schedule that shows the schedule dates for forming, placement, and stripping for each section of concrete placed within each structure.
10. Curing program description in sufficient detail to demonstrate that the Contractor will provide acceptable strength, finish, and crack control within the completed structure.
11. Product literature and technical data for waterstops, curing and sealing compounds, bonding compounds, surface hardeners, epoxy and chemical grout for crack injection, retardant.
12. Sample panels to demonstrate formed wall surface finishes as specified in Part 3.
13. Samples of concrete floor and slab finishes as specified in Part 3.
14. Concrete delivery truck tickets showing the information listed in ASTM C94, section 14.

1.05 QUALITY ASSURANCE

A. Quality Control By Owner:
   1. Special Inspection of concrete work shall be performed by the Special Inspector under contract with the Owner and in conformance with the IBC Chapter 17. Special Inspection of concrete is in addition to, not replacing, other inspections and quality control requirements specified herein. Where sampling and testing specified herein conforms to Special Inspection standards, such sampling and testing need not be duplicated.
   2. All structural concrete work shall receive Special Inspection in accordance with IBC Chapter 17. Structural concrete includes elements which resist code-defined loads and whose failure would impact life safety. Non-structural site work concrete does not require Special Inspection. Anchor bolts and anchors installed in hardened concrete require Special Inspection.
   3. Refer to Section 01 45 00 Quality Control, for Owner provided testing.

B. Quality Control By Contractor:
   1. Where required to demonstrate conformance with the specified requirements for cast-in-place concrete, the Contractor shall provide the services of an independent testing laboratory which complies with the requirements of ASTM E329. The testing laboratory shall sample and test concrete materials as specified in this section. Costs of testing laboratory services shall be borne by the Contractor.

C. Basis For Quality:
   1. Cast-in-place concrete shall conform to the requirements of ACI 301, except as modified herein.

D. Concrete Conference
   1. Contractor shall schedule and conduct a meeting to review the specification requirements and the proposed concrete design mixes, including procedures for producing proper concrete construction. Hold the meeting no later than 28 days after the Notice to Proceed.
   2. All parties involved in the concrete work shall be included to attend the conference, including the following: Contractor's representative, testing laboratory, concrete subcontractor, concrete supplier, Owner's Representative, and Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement:
   1. Portland cement shall be ASTM C150, Type II or Type V, low alkali, containing less than 0.60 percent alkalis. In addition to standard requirements, cement shall satisfy optional chemical and physical requirements of ASTM C150, Tables 2 and 4, respectively.
   2. If low alkali cement is not available, aggregates shall show an expansion of less than 0.1% when tested in accordance with ASTM C1260 or ASTM C1567 concrete mix test results shall be submitted verifying that the aggregates are not reactive per the criteria in this standard. ASTM C1260 and ASTM C1567 results shall be no older than 1 year.
   3. Portland-pozzolan cement shall be ASTM C595, Type IP (MS), interground, low alkali.
   4. Use cementitious materials that are of the same brand and type and from the same plant of manufacture as the cementitious materials used in the concrete represented by the submitted field test records or used in the trial mixtures. See Change of Materials paragraph below.

B. Ground granulated blast-furnace slag (GGBFS), if used in conjunction with portland cement, shall be per ASTM C989.

C. Aggregates:
   1. General:
      a. Except as modified herein, fine and coarse aggregates shall conform to ASTM C33. Fine and coarse aggregates are regarded as separate ingredients. Aggregates shall be non-reactive and washed before use.

b. Check aggregates for alkali-silica reactive constituents per ASTM C1260. Aggregate shall have less than 0.1% expansion when tested in accordance with ASTM C1260. Aggregates having 0.1% or greater expansion may still be satisfactory provided ASTM C1567 concrete mix test results are submitted and show an expansion of less than 0.1% at 16 days. Test results shall be no older than 1 year.

c. Tests for size and grading of fine and coarse aggregates shall be in accordance with ASTM C136. Combined aggregates shall be well and uniformly graded from coarse to fine sizes to produce a concrete that has optimum workability and consolidation characteristics. Establish the final combined aggregate gradation during mix design.

d. Aggregates used in the project production concrete shall be obtained from the same sources and have the same size ranges as the aggregates used in the concrete represented by the submitted historical data or trial mixtures. See Change of Materials paragraph below.

2. Fine Aggregate:

a. Fine aggregate shall be hard, dense, durable particles of either sand or crushed stone regularly graded from coarse to fine. Gradation shall conform to ASTM C33. For classes of concrete which will be used in liquid retaining structures, fine aggregate shall not exceed 40 percent by weight of combined aggregate total, except for concrete with coarse aggregate of less than maximum size 1/2 inch.

b. Variations from the specified gradations in individual tests will be acceptable if the average of three consecutive tests is within the specified limits and the variation is within the permissible variation listed below:

U.S. standard sieve size	Permissible variation in individual tests, percent
30 and coarser	2
50 and finer	0.5

c. Other tests shall be in accordance with the following specifications:

Test	Test method	Requirements
Amount of material	ASTM C117	3 percent passing No. 200 sieve maximum by weight
Sand equivalent	ASTM D2419	Minimum 70 percent

3. Coarse Aggregate:

a. Coarse aggregate shall be hard, dense and durable gravel or crushed rock free from injurious amounts of soft and friable particles, alkali, and organic matter. Other deleterious substances shall not exceed the limits listed in ASTM C33, Table 3 for Class Designation 5S. Gradation of each coarse aggregate size specified shall conform to ASTM C33, Table 2.

b. Variations from the specified gradations will be acceptable in individual tests if the average of three consecutive tests is within the specified limits.

D. Pozzolan:

1. Pozzolan shall be Class N, natural pozzolan, or Class F fly ash conforming to ASTM C618. Class C fly ash is not allowed. Pozzolan supplied during the life of the project shall have been formed at the same single source. See Change of Materials paragraph below.

2. The pozzolan color shall not substantially alter the resulting concrete from the normal gray color and appearance.
3. Use pozzolan materials that are of the same brand and type and from the same plant of manufacture as the materials used in the concrete represented by the submitted field test records or used in the trial mixtures.

E. Admixtures:
1. General:
   a. Admixtures shall be compatible with the concrete and with each other. Calcium chloride or admixtures containing calcium chloride are not acceptable. Use admixtures in accordance with the manufacturer's recommendations and add separately to the concrete mix. Water reducing retarders and admixtures shall reduce the water required by at least 11 percent for a given concrete consistency and shall comply with the water/cement ratio standards of ACI 211.1. Retarder dosage shall result in set time consistent with requirements specified in Part 3.
2. Water Reducing Admixtures:
   a. Conform to ASTM C494, Type A. Acceptable products include: BASF "MasterPozzolith 322"; SIKA Chemical Corp. "Plastocrete 161"; Euclid Chemical Co. "Eucon WR 91"; or approved equal.
3. Water Reducing and Retarding Admixtures:
   a. Conform to ASTM C494, Type D. Acceptable products include: BASF "MasterPozzolith 80"; Sika Chemical Corp. "Plastiment"; Euclid Chemical Co. "Eucon Retarder 75"; or approved equal.
4. High Range Water Reducing (Superplasticizing) Admixtures:
   a. Conform to ASTM C494, Type F. Acceptable products include: BASF "MasterGlenium" Series; Sika Chemical Corp. "Viscocrete 2100" or "Viscocrete 2110" (Hot Weather) or "Viscocrete 6100" (Cold Weather); Euclid Chemical Co. "Eucon 37"; W.R. Grace "ADVA 195"; or approved equal.
5. High Range Water Reducing And Retarding Admixtures:
   a. Conform to ASTM C494, Type G. Acceptable products include: W.R. Grace "Daracem 100"; Sika Chemical Corp. "Sikaplast 200" ; Euclid Chemical Co. "Eucon 537"; or approved equal.
6. Air Entraining Agent:
   a. Conform to ASTM C260 and produce air entrained concrete as specified in the Mix Proportioning table below. Acceptable products include: Sika Chemical Corp. "AEA-15"; Euclid Chemical Co. "AEA-92"; or approved equal.

F. Water:
1. For washing aggregate, mixing, and for curing shall be free from oil and deleterious amounts of acids, alkalis, and organic materials; comply with the requirements of ASTM C1602. Additionally, water used for curing shall not contain an amount of impurities sufficient to discolor the concrete.

G. Change of Materials:

1. After each concrete mix design is approved, no changes of any sort or source will be allowed without prior written approval from the Engineer. When brand, type, size, or source of cementitious materials, aggregates, water, ice, or admixtures are proposed to be changed, new field data, data from new trial mixtures, or evidence that indicates that the change will not affect adversely the relevant properties of the concrete shall be submitted for approval by the Engineer before use in concrete.

2.02 CONCRETE CHARACTERISTICS

A. Mix Proportioning:

1. Concrete shall be normal weight concrete composed of cement, pozzolan, admixtures, aggregates, and water; proportioned and mixed to produce a workable, strong, dense, and impermeable concrete. It is acceptable to substitute interground Portland-pozzolan cement conforming to ASTM C595, containing the specified amount of pozzolan in lieu of Portland cement and pozzolan. Water-cementitious material (w/cm) ratio is based on the combined contents of cement and pozzolan.
2. Provide concrete mix designs in accordance with the following guidlines:

Concrete class	Minimum[a] 28-day compressive strength, psi	ASTM coarse aggregate size	Maximum water-cementitious materials (w/cm) ratio	Minimum cementitious materials content (pounds/CY)	Pozzolan, percent by weight of cementitious materials	Air content (percent)	Slump range[d] (inches)
B	3000	57 or 67	0.45	560	15-20[c]	4-6	3-5
C-1	4500	57 or 67	0.40	560	15-20	4-6	3-5
E[b]	2000	57	--	-	15-20[c]	Not Required	4-8

[a] *Determine compressive strength at the end of 28 days based on test cylinders made and tested in accordance with ASTM C39.*

[b] *Concrete encasement for electrical conduit shall contain 3 pounds of red oxide per sack of cement.*

[c] *Pozzolan use is optional for this class of concrete.*

[d] *Slump before addition of high range water reducing admixture (superplasticizer). Maximum slump after addition of high range water reducing admixture shall be 8".*

B. Use:

1. Provide concrete by class for the uses listed below.

Concrete class	Type of use
B	Non-structural concrete (sidewalks, curbs, pavers, etc.)
C-1	Typical cast-in-place structural concrete
E[a]	Pipe bedding and encasement, electrical conduit encasement (duct banks) and concrete fill

[a] *Contractor's option to use the same concrete mix for pipe encasement as the concrete slab above.*

C. Control Tests:
    1. General:
        a. Select and adjust proportions of ingredients in accordance with ACI 211.1. Verification of mix characteristics for submittal may be achieved using either the Trial Mix Design method or Field Experience Data method. Do not place concrete prior to submittal and acceptance of proposed mix.
    2. Trial Mix Design:
        a. Mixes verified by this method shall have the samples produced for testing, manufactured at the batch plant which will supply concrete to the project, using materials proposed for the Work and material combinations listed above. Testing, data, and reporting shall conform to ACI 318 and the following:
            1) Required compressive strength used as the basis for selecting concrete proportions (f'cr) shall be the specified concrete strength (f'c) + 1000 psi for specified concrete strengths less than 3,000 psi and f'c + 1200 psi for specified concrete strengths between 3000 psi and 5000 psi.
            2) Make at least three different trial mixtures for each class of concrete qualified by the Trial Mix Design. Each trial mixture shall have a different w/cm ratio or different cementitious materials content that will produce a range of compressive strengths encompassing f'cr.
            3) Design trial mixtures to produce a slump within ¾ inch of the maximum specified and an air content within 0.5 percent of the maximum specified.
            4) For each w/cm ratio or cementitious materials content, cast and cure at least twelve standard test cylinders in accordance with ASTM C192. Four cylinders from each batch tested at age 7-days, 14-days, and 28-days or as required to comply with ACI 318.
            5) From results of the cylinder tests, plot a curve showing the relationship between w/cm ratio and compressive strength.
            6) From the curve of w/cm ratio versus compressive strength, select the w/cm ratio that will produce f'cr. This is the maximum w/cm ratio to be used unless a lower w/cm ratio is specified above.
    3. Field Experience Data:
        a. When sufficient test data for a particular mix design is available which is identical or substantially similar to that proposed for use, Contractor may substitute use of this data in lieu of a trial mix design. Field data, reports, and analysis shall conform to ACI 318, except as modified herein.
            1) Historical mix design proportions for which data are submitted may vary from the specified mix within the following limits:
                a) f'c as specified or up to 500 psi above
                b) w/cm ratio as specified or lower
                c) pozzolan content within 5 percent of that specified
                d) maximum coarse aggregate size may not vary smaller, but gradation of coarse aggregate may vary
                e) slump after introduction of admixtures +0/-1 inch.
        b. Use of historical Field Experience Data does not allow modification of the project mix specifications herein without review and acceptance by the Engineer.

4. Shrinkage:
    a. Liquid containing structures using Class C-1 concrete mix are intended to be watertight. Provide test results for Class C-1 concrete mix meeting the following requirement: drying shrinkage limit of 0.032 percent in the laboratory at 35-days (7-days moist cure and 28-days drying) as tested in accordance with ASTM C157 and the following modifications:
        1) Wet cure specimens for a period of 7-days (including the period of time the specimens are in the mold). Wet cure may be achieved either through storage in a moist cabinet or room in accordance with ASTM C 511, or through storage in lime saturated water.
        2) Slump of concrete for testing shall match job requirements and need not be limited to restrictions as stated in ASTM C 157 section 8.4.
        3) Report results in accordance with ASTM C 157 at 0, 7, 14 & 28-days of drying.
    b. Concrete shall not be placed in the field prior to acceptance of the concrete mix. To meet the drying shrinkage limit, it is recommended that a shrinkage reducing admixture be considered for use in concrete for liquid containing structures.

2.03 WATERSTOPS

A. Polyvinyl Chloride (PVC):
    1. Manufacture PVC waterstops from virgin polyvinyl chloride conforming to the Corps of Engineers Specification No. CRD-C572. Use 6-inch flat center/ribbed sides/0.375 inch thick less waterstops in construction joints. Acceptable products include: Greenstreak Group, Inc. “Model 679”; Vinylex Waterstops and Accessories “Model R638”; or approved equal. Use 9 inch center-bulb/ribbed sides/0.375 inch thick waterstops in expansion joints. Acceptable products include: Greenstreak Group, Inc. “Model 696”; Vinylex Waterstops and Accessories Model “RLB938”; or approved equal.
    2. Use molded crosses, tees, and other shapes for changes of direction, intersections, and transitions as recommended by the manufacturer.

B. Expanding (Hydrophilic) Waterstops:
    1. Expanding waterstops shall be bentonite-free and made from unvulcanized rubber. Acceptable products include: Adeka Corporation “Ultra Seal MC-2010MN”; Greenstreak Group, Inc. “Hydrotite CJ-1020-2K”; or approved equal. These are allowable for use only where indicated on the drawings or accepted in writing by the Engineer. Provide adhesive approved by the waterstop manufacturer plus concrete nails and fender washers to secure waterstop material in-place during concrete placement. The waterstop MUST be placed between two mats or curtains of steel reinforcement.
    2. For limited cover applications or where only one mat or curtain of reinforcement is present, use Adeka Corporation “Ultra Seal KBA-1510FP”or approved equal.

2.04 SEALANTS AND JOINT FILLERS

A. Sealants and preformed joint fillers are specified in Sections 07 92 00 and 07 91 26.

2.05 BONDING COMPOUNDS

A. Epoxy resin bonding compounds for use in wet areas shall conform to ASTM C881 Types IV or V, Class A, B, or C depending on temperature at use. Acceptable products include: BASF “MasterEmaco ADH 327RS” or “MasterEmaco ADH 1490”; Sika Chemical Corporation “Sikadur 32”; or approved equal.

B. Non-epoxy bonding compounds for use in dry areas for non-structural bonding or as noted on the drawings shall conform to ASTM C1059 Type II. Acceptable products include: Edoco “Burke Acrylic Bondcrete”; ChemMasters “Cretelox”; or approved equal.

C. Apply bonding compounds in accordance with the manufacturer’s instructions.

2.06 EPOXY FOR CRACK INJECTION

A. Use a two-component, moisture insensitive, high modulus, injection grade, 100 percent solids, epoxy-resin blend. Consistency as required to achieve complete penetration into cracks. Material shall conform to ASTM C881 Type 1 Grade 1. Acceptable products include: Sika Corporation “Sikadur 52”; Adhesives Technology Corporation “Crackbond SLV302”; or approved equal.

B. Use epoxy injection for structural crack repairs except as noted below for non-structural cracks in liquid-containing concrete structures. The Engineer shall determine whether a crack is classified as structural or non-structural.

2.07 CHEMICAL GROUT FOR CRACK INJECTION

A. Use hydrophobic polyurethane grout at the Engineer's discretion as an alternative for sealing non-structural cracks in concrete structures intended to be watertight. Acceptable products include: DeNeef Construction Chemicals "Hydro Active Cut" and “Flex SLV PURe” or Sika Corporation “SikaFix HH Plus” and “SikaFix HH LV”; or approved equal.

2.08 RETARDANT

A. Retardant for exposing aggregate for unformed surfaces in construction joints shall be Sika Corporation“Rugasol-S”; W.R. Grace “Top-Cast”; or approved equal.

B. Apply retardant in accordance with manufacturer’s instructions sufficient to assure a minimum penetration of 1/4 inch.

2.09 SURFACE HARDENER

A. Moderate Duty Hardener:
   1. Use a premixed, non-colored, and non-metallic hardener. Acceptable products include: BASF “MasterTop 100”; or approved equal.
   2. Apply hardener in accordance with manufacturer’s instructions, in an amount of at least 0.75 pounds per square foot for commercial, light duty traffic and 1.25 pounds per square foot for heavy duty traffic and process spaces. Product and/or application procedure shall be coordinated with air content of concrete being placed.

B. Heavy Duty Hardener:
   1. Use an emery aggregate dry shake applied during slab finishing. Acceptable products include: L&M Construction Chemicals “Emeryplate FF”; or approved equal.
   2. Apply in accordance with manufacturer’s recommendations at a minimum rate of 1.5 pounds per square foot; adjust for the specific floor traffic and use anticipated. Product and/or application procedure shall be coordinated with air content of concrete being placed.

C. Hardener For Existing Concrete:
   1. Use an alkaline siliconate solution to harden, densify, and seal the surface. Acceptable products include: L&M Construction Chemicals “Seal Hard”; or approved equal.
   2. Proposed product shall be approved by Owner after review of similar floors so-treated for at least 2 years.

2.10 CURING AND SEALING COMPOUNDS

A. Acceptable products include: BASF “MasterKure CC 250SB”; Dayton Superior “Cure & Seal 25% J22UV”; or approved equal, conforming to ASTM C309 and ASTM C1315.

B. Compound shall be clear and applied in accordance with the manufacturer’s instructions.

C. Curing and sealing compound shall be certified compliant with final finish system if applicable.

PART 3 EXECUTION

3.01 GENERAL

A. Use only truck-mixed, ready-mixed concrete conforming to ASTM C94. Proportion materials by weighing.

B. Introduce pozzolan into the mixer with cement and other components of the concrete mix; do not introduce pozzolan into a wet mixer ahead of other materials or with mixing water.

C. Introduce water at the time of charging the mixer; additional water may be introduced within 45 minutes from charging the mixer, provided the specified w/c ration and slump is not exceeded and the maximum total water per the approved mix design is not exceeded.

D. Arrange with the testing laboratory for inspection as required to comply with these specifications.

E. Deliver concrete to the site and complete discharge within 90 minutes after introduction of water to the mixture. Extension of allowable time beyond this limit requires a Contractor proposed remedial action plan to be reviewed and accepted by the Owner’s Representative.

3.02 CONVEYING AND PLACING CONCRETE

A. Convey concrete from the mixer to the forms in accordance with ACI 301. Remove concrete that has segregated in conveying from the site of the work.

B. Placing Concrete:
   1. General:
      a. Place concrete in accordance with ACI 301. Do not permit concrete to drop freely more than 4-ft.
   2. Placing Concrete By Pumping:
      a. Concrete placed by pumping is at Contractor's discretion and shall not be the cause to change or relax specified mix design characteristics. Concrete shall possess the specified characteristics at the point of placement.
      b. Measure slump at the hose discharge, except as follows: Initial slump testing in each placement shall occur at both the pumping unit inlet hopper and hose discharge. Slump loss in pumping, measured between the inlet hopper and the hose discharge, shall not exceed 1 inch. After these criteria have been satisfied, slump may be measured at the inlet hopper with allowable slump increased by the earlier measured difference, not to exceed 1 inch.
      c. Measure air content at the hose discharge, except as follows: Initial air content testing shall occur at both the pumping unit inlet hopper and the hose discharge. Loss of air content shall be measured between the inlet hopper and the hose discharge. Increase the air content of the delivered concrete at the inlet hopper to provide the specified air content at the hose discharge. After these criteria have been satisfied, air content may be measured at the inlet hopper.
      d. Before starting each pumping operation, prime the pump and line with a cement slurry to lubricate the system. Waste cement slurry outside the forms. Equip hose tip with a safety chain for recovery in case of hose blowout during pumping. Hose or accessories shall not remain in the freshly placed concrete.
      e. Use tremie placing techniques and equipment for pump placed concrete. Pump discharge system shall remain full of concrete from pump to discharge point at all times. Concrete pumping shall not occur until Owner's Representative has verified equipment including the tremie plug. Should the discharge line become open, with zones empty of concrete, cease pumping and re-primed with tremie plug installed before continuing.
   3. Placing Concrete In Hot Weather:
      a. In temperatures above 80 degrees F, place concrete in accordance with ACI 305.1.
   4. Placing Concrete In Cold Weather:
      a. In temperatures below 45 degrees F, place concrete in accordance with ACI 306.1.

3.03 CONSOLIDATING CONCRETE:

A. Consolidate concrete in accordance with ACI 301. If evidence of inadequate consolidation is observed, concrete placement will be suspended until Contractor provides a revised plan to achieve proper consolidation.

3.04 CURING AND SEALING

A. General:
   1. Cure concrete using water, a clear membrane curing compound, or by a combination of both methods. Coordinate repairs or treatment of concrete surfaces so that interruption of curing will not be necessary.
   2. Maintain concrete surface temperature between 50 degrees F and 80 degrees F for at least 5 days. Cure concrete in hot weather (above 80 degrees F) in accordance with ACI 305.1. Cure concrete in cold weather (below 45 degrees F) in accordance with ACI 306.1.

B. Water Curing:
   1. Keep concrete continuously wet for a minimum of 10-days after placement. Absorptive mats or fabric may be used to retain moisture during the curing period.
   2. Use water curing in hot weather for liquid containment structures. Cover forms and keep moist. Loosen forms as soon as possible without damage to the concrete, and make provisions for curing water to run down inside them. During form removal, take care to provide continuously wet cover to newly exposed surfaces.

C. Curing Compound:
   1. When curing compound is allowed, apply it as soon as the concrete has set sufficiently so as not to be marred by the application or apply it immediately following form removal for vertical and other formed surfaces. Preparation of surfaces, application procedures, and installation precautions shall follow manufacturer's instructions. For liquid containing structures, apply curing compound at twice the manufacturer's recommended dosage rate, applied in two coats perpendicular to each other.
   2. Do not use curing compound on concrete surfaces to be coated, waterproofed, moisture-proofed, tiled, roofed, or where other coverings are to be bonded In these cases, use water curing unless the curing compound is first removed or is compatible with the final finish covering.

3.05 PROTECTION

A. Protect concrete from injurious action by sun, rain, flowing water, frost, and mechanical means.

B. Loading green concrete is not permitted. Green concrete is defined as concrete with less than 100 percent of the specified strength.

C. Backfill shall not be placed against concrete walls until the concrete has reached the specified strength, connecting slabs and beams have been cast and have also reached the specified strength, and watertightness testing and repairs have been completed for liquid containing strutures to the satisfaction of the Owner's Representative.

D. Arrangements for covering, insulating, heating, and protecting concrete in cold weather shall be in accordance with ACI 306.1.

3.06 CONSTRUCTION JOINTS

A. General:
   1. Place concrete in each unit of construction continuously. Before new concrete is placed on or against concrete which has set, retighten forms and clean foreign matter from the surface of the set concrete. Provide waterstops as specified.

B. Construction:
   1. Form construction joints by producing a rough surface of exposed aggregates using a surface retardant; include joints between the slab and topping concrete. The limit of the treated surfaces shall be 1 inch away from the joint edges. Within 24 hours after placing, remove retarded surface mortar either by high pressure water jetting or stiff brushing or combination of both so as to expose coarse aggregate. A rough surface of exposed aggregate may also be produced by sandblasting followed by high pressure water jetting. Sandblasting, if used, shall remove 1/4 inch of laitance film and expose coarse aggregate to ensure adequate bond and watertightness at the construction joints.

C. Locations:
   1. Provide construction joint locations as follows:
      a. Cast walls exceeding 50 feet in length in panels not to exceed 30 feet in length. Cast adjoining panels only after 5-days have elapsed. Joints are not allowed within the lesser of 10 feet or 25 percent of the wall length from a corner unless specifically detailed thus on the drawings.
      b. Locate joints in beams or girders at or near the quarter point between supports.
      c. Make joints in the members of a floor system at or near the quarterpoint of the span.
      d. Make joints in walls and columns at the underside of floors, slabs, beams or girders and at the tops of footings or floor slabs.
      e. Cast slab panels in checkerboard patterns not to exceed 40 feet in length and not to exceed 900 square feet in area, with maximum 1 ½ to 1 ratio of side lengths. Minimum lapsed time between placing adjacent panels shall be 3-days. The requirements for size of slab panel is waived if joints are located on the Drawings.
   2. Vertical construction joints shall have edges grooved or beveled at faces exposed to view including interior faces of basins and tanks. Seal grooves subjected to wetting or weather with joint sealant.
   3. Continue reinforcing steel and welded wire reinforcement through construction joints. Beams, girders, and floor slabs shall not be constructed over columns or walls until at least one day has elapsed to allow for initial shrinkage in the column or wall. No joint will be allowed between a slab and a beam or girder unless otherwise shown. Joints shall be perpendicular to the main reinforcement. Provide waterstops in construction joints as specified.

3.07 INSERTS AND EMBEDMENTS

A. Inserts:
   1. Where pipes, castings, or conduits are to pass through structures, position in forms before placing concrete; or where shown on Drawings or approved by the Owner's Representative, provide openings in the concrete for subsequent insertion of such pipes, castings, or conduits. Provided waterstops and a slight flare in the form to facilitate grouting and permit the escape of entrained air during grouting.
   2. Provide additional reinforcement around openings. Use non-shrink grout to infill around inserts.
   3. Place horizontal conduits and pipes, in slabs and beams, between the top and bottom layers of reinforcement. Spacing and size limitations shall conform to ACI 318.
   4. Conduits and pipes shall not run directly beneath a column or base plate.
   5. Position conduit, pipe, dowels, and other ferrous items such that there will be a minimum of 2-inches clearance between said item and concrete reinforcement. Welding inserts to reinforcement is not permitted.
   6. The outside diameter of conduit or pipe shall not exceed one-fourth the slab or beam thickness.

B. Embedments:
   1. Gate frames, gate thimbles, special castings, channels, grating frames, or other miscellaneous metal parts to be embedded in concrete shall be secured in the forms prior to concrete placement.
   2. Embed anchor bolts and inserts in concrete as shown. Provide inserts, anchors, or other bolts necessary for the attachment of piping, valves, metal parts, and equipment.
   3. Provide nailing blocks, plugs, strips, and the like necessary for the attachment of trim, finish, and similar work. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent entry of concrete. Do not use continuouse anchor slots or strips in concrete intended to be watertight.
   4. Positon operators or sleeves for gate or valve stems to clear reinforcing steel, conduit, and other embedments, and to align accurately with equipment.

3.08 EXPANSION JOINTS

A. Expansion joints shall be as shown. Do not extend reinforcement or other embedded metal items through expansion joints. Provide waterstops where indicated.

3.09 WATERSTOPS

A. Waterstops shall conform to ACI 301. Tie waterstops in position prior to placement of concrete to prevent movement and deformation.

B. Provide waterstops in construction and expansion joints as follows:
   1. Joints in parts of structures exposed to ground or water on one side and occupied by non-submerged equipment or by personnel on the other.
   2. Wall and slab joints of tanks and channels subject to water pressure.

3. Waterstops shall be provided for the full height of the walls.
4. Provide at other locations shown on the Drawings.

C. Field splices shall be at straight sections using heat fused welded, butt splices only. Lapping of splices or joining by means other than heat fused welding is not allowed.

D. Install hydrophilic waterstops according to manuacturer's recommendations. Surfaces of concrete shall be prepared level/plumb and to the smoothness required by manufacturer. Grind surface as necessary. Provide bonding adhesive and concrete nails with fender washers to hold waterstop in position during concrete placment.

3.10 MODIFICATION OF EXISTING CONCRETE

A. General:
1. Verify structural dimensions related to or controlled by previously constructed or existing structures prior to concrete work.

B. Cutting or Coring Concrete:
1. Saw cut concrete to a depth of 1 inch to form straight outlines of concrete areas to be removed. Where reinforcement is exposed due to saw cutting or core drilling and no new material is to be placed on the cut surface, provide a protective epoxy coating to the entire cut surface.
2. Coat surfaces of oversized openings with an epoxy bonding compound prior to re-finishing with profiling mortar to the required opening size.
3. Grind existing joint edges to create a chamfer matching those used on adjacent construction.
4. Investigate concrete to be drilled, cored, or sawcut to determine location of reinforcing steel. Locate penetrations to clear existing reinforcing steel. Where not possible to avoid reinforcing steel, consult the Engineer as to acceptability of cutting reinforcing steel and provide new reinforcing systems as directed.
5. Locating methods include chipping to expose reinforcing steel, ground penetrating radar, X-ray, or magnetic flux devices. Locates of existing reinforcing shall be by the Contractor.

C. Joining New Concrete To Existing:
1. Existing concrete surfaces to be joined with new concrete shall be cleaned and roughened by abrasive blasting, bush hammering, or other method to achieve ¼-inch amplitude surface. Remove existing metalwork, embeds, or other interfering items. Coat existing surface with epoxy bonding compound prior to placement of new concrete.

D. Post-Installed Anchors and Dowels:
1. Use non-destructive methods for locating reinforcement prior to drilling operations. For anchor and dowel locations that interfere with reinforcement, attempt to relocate to avoid drilling through the reinforcement if possible.
2. For situations that do not allow relocation, cutting of reinforcement for installation is subject to the following:
a. Prior to drilling through reinforcement, the Contractor shall consult the Owner's Representative or Engineer.

b. Drill holes with a hammer drill and carbide bit (core drilled holes are not allowed), followed by brushing and air-cleaning with oil-free compressed air.
c. Holes drilled through reinforcement must be in compliance with adhesive anchor assumptions for roughened hole surface typical of a hammer drill and carbide bit. No smooth hole surfaces are allowed.
d. Do not cut slab rebar within 24 inches of a supporting wall, column, or an opening in the slab.
e. No cutting of rebar is allowed in the middle third of slab spans for anchors with diameters equal to or greater than 3/4 inch.
f. Maximum of two rebar may be cut in any 10 foot width of slab.
g. Maximum of two rebar may be cut within any 10 foot width of concrete wall.
h. Maximum of one rebar may be cut within any 8 foot width of CMU wall.

3. For anchors that cannot be moved and that conflict with the above requirements, consult Engineer for direction. It is not acceptable to cut reinforcement in beams, columns, precast members, or stairs.
4. Use a pre-manufactured, self-mixing, injectable, two-component, epoxy adhesive, as per Section 03 60 00. Follow manufacturer's recommendations and ICC Evaluation Report for installation.

E. Waterstops:
1. Where a waterstop between new and existing concrete is required, install either a hydrophilic waterstop or a retrofit waterstop as indicated.

3.11 FORMED SURFACE FINISHES

A. Repair Of Surface Defects:
1. Repair surface defects, including tie holes, minor honeycombing, or otherwise defective concrete in accordance with ACI 301. Clean areas to be repaired. Cut and chip out honeycombed or otherwise defective areas to solid concrete, to a depth of at least 1-inch. If defective area includes exposed reinforcing steel, correct by removing concrete a minimum of 1-inch beyond the reinforcing. Make edges of the cut perpendicular to the surface of the concrete in a neat rectangular patern.
2. Joints shall be grooved to a radius or bevel of ¾-inch depth.
3. Finish patches on exposed surfaces to match and blend with adjoining work. Cure patches as specified for the concrete. Protect finished surfaces from stains and abrasions.

B. Formed Surface Finishes:
1. Finish A - Grout Rubbed Finish
a. After repair of surface defects, apply a grout rubbed finish in accordance with ACI 301 except that all form fins and other protrusions shall be completely removed. Lightly sandblast surfaces prior to sacking. Sandblasting shall occur after the specified curing period.
b. Add a PVA bonding compound to the mix water used in sacking mortar; as recommended by the manufacturer.

c. Provide Finish A at uncoated surfaces of stair wells, interior surfaces of equipment rooms, galleries, tunnels, operations areas, exposed channels and tanks from 1 foot below minimum water surfaces and up, and at permanently exposed vertical and sloped surfaces such as pipe chases.

d. Do not provide Finish A at concrete surfaces receiving a coating.

2. Finish B - Smooth Surface Finish

a. Initial surface preparation is the same as Finish A; repair surface defects and remove all form fins.

b. Provide Finish B at surfaces to be coated. See Section 09 90 00 for additional concrete surface preparation, including filling of bug holes, and coating requirements.

3. Finish C - Rough Form Finish

a. Repair surface defects and imperfections greater than 3/8 inch in any dimension. Remove form fins and protrusions down to less than 3/8 inch projection.

b. Provide Finish C or smoother, for interior surfaces of wet wells, tanks, and channels; from 1 foot below minimum water surface and down.

c. Also apply Finish C to unoccupied interior areas not otherwise specified.

4. Finish D – Unfinished Surface

a. Repair surface defects and otherwise leave the surfaces as they come from the forms, except plug tie holes and repair or remove defects greater than 1/2 inch in any dimension.

C. Sample Of Formed Surface Finish A:

1. Provide a sample concrete panel, minimum 4 feet by 4 feet; representative of formed surface Finish A. The panel shall be representative of the workmanship and finish required, including repair of defects, filling of tie holes, sandblasting, and rubbing.

2. The sample shall be approved by the Owner's Representative prior to the start of production work. The sample shall be on display at the job site, and finished surfaces shall match sample.

3.12 SLAB FINISHES

A. General:

1. The finishes specified herein include surface finishes, treatments and toppings for floors and slabs. Do not use dry cement on new concrete surfaces to absorb excess moisture. Round edges to a radius of 1/2 inch.

2. Slope floors to drain uniformly within a room or space. Unless otherwise specified, slope shall be a minimum of 1/8 inch per foot toward nearest drain. Restrict use of floor drains with only locally depressed slabs to locations specifically noted.

3. Immediately after final finish is applied, the surface shall be cured and protected as specified in Curing, Sealing, and Protection paragraphs above.

4. Where finish is not specified, floor slabs shall receive a Steel Trowel Finish.

B. Float Finish:
   1. Perform floating with a hand or power-driven float in accordance with ACI 301. Begin floating when the bleed water sheen has disappeared and the surface has stiffened sufficiently. Float as required to meet tolerance requirements of ACI 117 for a conventional surface.
   2. Floating shall close cracks and checks plus compact and smooth the surface. Refloat the slab to a uniform texture.
   3. Applly float finish to surfaces of channels, tank bottom slabs, tops of footings, and surfaces to receive insulation or roofing.

C. Steel Trowel Finish:
   1. Float the concrete surface as indicated above and then trowel in accordance with ACI 301.
   2. Provide Steel Trowel Finish on floors and walking surfaces unless specified otherwise.

D. Broom Finish:
   1. Float the concrete surface as indicated above, then immediately give the concrete a coarse transverse scored texture by drawing a broom or burlap belt across the surface in accordance with ACI 301.
   2. Provide a Broom Finish for walks, top of tank walls, slabs-on-grade exposed to atmosphere, and where otherwise indicated.

E. Samples Of Concrete Slab Finishes:
   1. Provide a sample concrete slab, minimum 4 feet by 4 feet, representative of workmanship and each specified finish.
   2. Samples shall be approved by the Owner's Representative prior to the start of production work. The samples shall be on display at the job site, and finished surfaces shall match samples.

3.13 RELATED SURFACES

A. Stair Treads:
   1. Construct stair treads with a nonskid nosing as specified in Section 05 50 00.
   2. Treads shall have a Float Finish followed by a Steel Trowel Finish with a slope of 1/8 inch toward the front.

B. Finishing of Unformed Surfaces:
   1. Adjacent Unformed Surfaces:
      a. Tops of walls, buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed and shall be Float Finished to a texture reasonably consistent with that of the adjacent formed surface.
      b. Continue final treatment of formed surface uniformly across the top of the unformed surface.
   2. Pavements and Sidewalks:
      a. The surface of the concrete shall be screeded to grade and sloped to drain. After screeding, the surface shall be Float Finished followed by a Broom Finish.

b. Round edges and expansion joints to a radius of 1/2 inch. Control joints shall be grooved or sawcut to a minimum depth of 1/4 the slab thickness.

3.14 FIELD SAMPLING AND TESTS

A. General:
   1. Field sampling and tests shall be performed by an independent testing laboratory. Samples of aggregates and concrete will be obtained at such times to represent the quality of the materials and work throughout the project.
   2. The laboratory shall provide necessary labor, materials and facilities for sampling aggregate and for casting, handling, and initially storing the concrete samples at the work site.
   3. The minimum number of samples and tests are specified in Testing paragraph below.

B. Sampling:
   1. Aggregates:
      a. General:
         1) Sample fine and coarse aggregates in accordance with ASTM D75 not less than 30 days prior to the use of such aggregates in the work.
         2) Take samples at the discharge gates of the bins feeding the weigh hopper. Repeat sampling when the source of material is changed or when unacceptable deficiencies or variations from the specified requirements of materials are found.
         3) Aggregate samples shall be tagged and their sources idenified.
      b. Coarse Aggregate:
         1) Take a sample weighing between 50 and 60 pounds after the batch plant is brought up to full operation.
         2) Take samples to obtain a uniform cross section, accurately representing the materials on the belt or in the bins for sieve analysis.
      c. Fine Aggregate:
         1) Take samples as specified for coarse aggregate.
         2) Take samples of sand when the sand is moist for sieve analysis and specific gravity tests.
   2. Concrete:
      a. Take samples of plastic concrete in accordance with ASTM C172.
      b. Take samples at the hopper of mixing equipment or transit mix truck, except as noted in the Placing Concrete by Pumping subparagraph of the Conveying and Placing article above.

C. Testing:
   1. Aggregate:
      a. A minimum of one test of coarse aggregate per 400 cubic yards of concrete used and a minimum of one test of fine aggregate per 200 cubic yards of concrete used shall be made to confirm continuing conformance with specifications for gradation, cleanliness and sand equivalent.
      b. A maximum of one test per day of each aggregate is required.
      c. Repeat of the entire concrete mix design test program is required before source changes will be accepted.
   2. Concrete:
      a. Strength Tests:
         1) The strengths specified for the design mix shall be verified by the independent testing laboratory during placement of the concrete. Verification shall be accomplished by testing standard cylinders of concrete samples taken at the job site. Cylinders shall be 4 by 8 inch or 6 x 12 inch.
         2) Concrete samples shall represent the concrete placed in the forms. One set of six standard 6 x 12 inch (or nine 4 x 8 inch) cylinders shall be cast of each class of concrete for each 100 cubic yards or less, or for each 5,000 square feet of slab or wall surface area placed per day. Provide additional cylinders when an error in batching is suspected. Each set of cylinders are cast from material taken from a single load of concrete.
         3) Casting, handling and curing of cylinders shall be in accordance with ASTM C31. For the first 24 hours after casting, keep cylinders moist in a storage box constructed and located so that its interior air temperature will be between 60 and 80 degrees F. At the end of 24 hours, the testing laboratory will transport the cylinders to their laboratory.
         4) Testing of specimens for compressive strength shall be in accordance with ASTM C39. Each test shall consist of two 6 x 12 inch (or three 4 x 8 inch) test cylinders from each group of six (or nine) specimens. Test at the end of 7 days and at the end of 28 days. The remaining cylinders shall be tested at the end of 56 days if the 28-day strength reports below specification.
         5) A strength test shall consist of the average strength of two 6 x 12 inch (or three 4 x 8). If one cylinder shows evidence of low strength due to improper sampling, casting, handling, or curing, the result of the remaining cylinders may be used if approved by the Owner's Representative.
         6) The average of any three consecutive 28-day strength test results of the cylinders representing each class of concrete for each structure shall be equal to or greater than the specified strength. Not more than 10 percent of the individual strength test results shall have values less than the specified 28-day strength for the total job concrete. No individual strength test result shall be less than the specified strength by more than 500 pounds per square inch.

7) Provide certified reports of the test results directly to the Owner's Representative and the Engineer. Test reports shall include sufficient information to identify the mix used, the stationing or location of the concrete placement, and the quantity placed. Slump, water/cement ratio, air content, temperature of concrete, and ambient temperature shall be noted.

8) The 28-day strength test results shall be evaluated in accordance with ACI 214R. Quality control charts showing field test results shall be included with the test results for each class of concrete in each major structure. Charts shall be prepared in accordance with ACI 214R. Quality control charts shall be maintained throughout the entire project and shall be available for the Owner's Representative's inspection at any time.

9) If the 28-day test results fall below the specified compressive strength for the class of concrete required for any portion of the work, adjustment in the proportions, water content, or both, shall be made as necessary at the Contractor's expense. Report changes and adjustments in writing to the Owner's Representative.

10) If compressive test results indicate concrete in place may not meet structural requirements, tests shall be made to determine if the structure or portion thereof is structurally sound. Tests may include, but not be limited to, cores in accordance with ASTM C42 and any other analyses or load tests acceptable to the Engineer. Costs of such tests and/or anlysis shall be borne by the Contractor.

b. Tests for Consistency of Concrete:

1) Measure slump in accordance with ASTM C143. Take samples for slump determination from concrete during placement. Tests shall be made at the beginning of concrete placement operation, whenever test cylinders are cast, and at subsequent intervals to ensure that the specification requirements are met.

2) For pumped concrete, measure slump in accordance with the Placing Concrete by Pumping subparagraph of the Conveying and Placing article above.

3) When high range water reducer is added at the site, slump tests shall be taken before and after addition of the admixture.

c. Tests for Temperature and Air Content:

1) Temperature tests shall be made at frequent intervals during hot or cold weather conditions until satisfactory temperature control is established. Perform temperature tests whenever test cylinders are cast.

2) Measure air content in accordance with ASTM C231 whenever test cylinders are cast. For pumped concrete, measure air content in accordance with the Placing Concrete by Pumping subparagraph of the Conveying and Placing article above.

D. Final Laboratory Report:

1. The testing laboratory shall provid a final report at the completion of all concreting. This report shall summarize the findings concerning concrete used in the project and provide totals of concrete used by class and structure.

2. Include final quality control charts for compressive strength tests for classes of concrete specified in each major structure. Also include the concrete batch plant's coefficient of variation and standard deviation results for each class of concrete.

3.15 REPAIR OF DAMAGED AND CRACKED CONCRETE:

A. Acceptance Of Concrete:
   1. Completed cast-in-place concrete work shall conform to the applicable requirements of ACI 301 and the Contract Documents. Concrete work that fails to meet these requirements shall be repaired, as approved by the Engineer, to bring the concrete into compliance. Repair methods shall be in accordance with ACI standards, including ACI 503.7, and are subject to the approval of the Engineer.
   2. Concrete that cannot be brought into compliance by approved repair methods will be rejected. Remove and replace rejected concrete work.
   3. The cost of repairs and replacement of defective concrete shall be borne by the Contractor.

B. Repair Methods:
   1. Damaged/defective concrete or concrete with crack widths exceeding 0.004 inches at liquid-containing and conveying structures or crack widths exceeding 0.006 inches for other structures shall be repaired by one of the following methods (only the Engineer may determine that a defect or crack does not require repair):
      a. Perform watertightness testing and repair as needed to meet leakage criteria in this specification even when liquid-containing and conveying structures meet the crack width criteria defined above.
      b. Damaged or defective concrete includes surface defects, honeycomb, rock pockets, indentations greater than 3/16 inch, spalls, chips, air bubbles greater than 1/2 inch diameter, pinholes, bugholes, embedded debris, lift lines, sand lines, bleed lines, leakage from form joints, fins, projections, form popouts, texture irregularities, and stains or other color variation that cannot be removed by cleaning.
         1) Damaged or defective concrete is repaired according to procedures outlined above under finish requirements, Repair of Surface Defects.
   2. Crack Repair Method 1:
      a. Fill the joint or crack by drilling holes to the affected area (following the product manufacturer's details), install injection ports, and force epoxy or chemical grout (expanding urethane) into the joint under pressure.
      b. Material type and repair proceedures shall be approved by Engineer.
      c. After injection and curing; ports, sealing mix, and surface shall be cleaned and worked to match the adjacent specified finish.
   3. Crack Repair Method 2:
      a. Fill cracks with low viscosity epoxy, applied by pouring/flooding crack zone until cracks are filled. Prepare surface, install, and cure according to manufacturer's recommendations.
      b. At a minimum, prepare surface to be clean and dry with no visible detrimental material in cracks to be filled. Conform to temperature limitations of epoxy. Clean and refinish to match adjacent surfaces.
   4. Crack Repair Method 3:

a. Cut a bevel groove 3/8 to 1/2 inch in width and depth, use backer rod or tape, and fill with sealant in accordance with manufacturer's instructions.
b. This repair method is only used where approved by Engineer.
c. Groove and sealant shall be applied on wet or hydrostatic pressure side of surface.

C. Repair Method Use:
1. Repair Method 1: For cracks in walls, surfaces sloped 1:1 or greater, beams, columns, structural slabs, overhead surfaces, and liquid retaining surfaces. Need for repair depends upon crack width, location, and leakage.
2. Epoxy grout is used for repair of structural cracks and chemical grout (expanding urethane) for repair of non-structural cracks at liquid-containing structures. The Engineer shall determine whether a crack is classified as structural or non-structural.
3. Repair Method 2: Utilized in lieu of Method 1 for slabs when approved by Owner's Representative. Final finish shall match adjacent surfaces.
4. Repair Method 3: Limited to dry-surface slabs, walls subject to less than three feet of liquid pressure, or as approved by Engineer. Repair Method 3 is not an equivalent repair method to Repair Methods 1 or 2, which shall be considered the standards.

3.16 WATERTIGHTNESS TESTING AND REPAIR

A. Liquid Containing Concrete Tanks And Channels:
1. Watertightness testing shall comply with ACI 350.1 and the following requirements:
2. Concrete tanks, basins, reservoirs and channels which have walls or slabs subjected to hydrostatic pressure shall be tested for watertightness. The tests shall be made after the structure is complete and the concrete has achieved its specified 28-day strength, but prior to application of waterproof coating or backfill.
3. Filling of the tank for watertightness testing shall not exceed a rate of 4 feet/hour. Fill with water to the maximum operating water surface. Keep water at this level for at least 72 hours prior to start of test.
4. Testing includes visual inspection of the dry sides of all walls, wall base construction joint at top of the slab, and the soffit of elevated slabs for evidence of leakage. Damp spots, leakage, or seepage revealed by the test, including those caused by shrinkage of concrete, honeycombed areas, construction joints, or other sources shall be repaired by Repair Method 1 (see Repair Methods paragraph in the Repair of Damaged Concrete and Cracking article above).
5. Damp spots are defined as areas from which water that can be picked up on dry hand and smeared across the dry concrete surface.
6. Re-test tanks or channels which have been repaired to check the suitability of repairs.
7. Provide water required for testing and re-testing and dispose of in an approved manner.
8. After repair of visual leakage, liquid containing or conveying concrete structures supported on soil must also meet maximum leakage criteria into the soil through their base slab or mat foundation as follows:

Structure Type	Tightness Criterion
Rectangular basins and tanks	0.050 percent per day

Note: All damp spots and/or leakage through walls, wall-to-slab joints, and elevated slabs shall first be repaired as described above. Leakage into soil equal to or less than the values shown in the table above is permitted only through base slabs on soil or mat foundations.

9. Record volume loss by measuring the vertical distance from the water surface to a fixed point on the tank above the water surface. Account for evaporation from open surfaces.
10. If the drop in water surface during the 24-hour test period exceeds the values given in the table above, exclusive of evaporation, the leakage is considered excessive and shall be remedied.

3.17 CLEANUP

A. Upon completion of the work and prior to final inspection, clean all concrete surfaces as follows: Sweep with a broom to remove loose dirt, then mop and/or flush with clean water. Scrub by hand or machine as required to remove and blend stains or discolored areas .

B. Clean floors that have curing and sealing compound as stated above, followed by the final application of curing and sealing compound.

END OF SECTION

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SECTION 03 48 11

PRECAST CONCRETE VAULTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Factory design and manufacture of precast concrete vault sections and accessories.

B. Quality assurance and control.

C. Field installation of vaults.

D. Waterproofing and epoxy coating of vaults.

E. Installation of frames, hatches, and fall protection.

F. Ladders and safety devices.

G. Vault schedule.

1.02 RELATED SECTIONS

A. Section 03 11 00 - Concrete Forming

B. Section 03 20 00 - Concrete Reinforcement

C. Section 03 30 00 - Cast-In-Place Concrete

1.03 REFERENCES

Reference	Title
ASTM C150	Portland Cement
ASTM C207	Hydrated Lime for Masonry Purposes
ASTM C478	Precast Reinforced Manhole Sections
ASTM C858	Underground Precast Concrete Utility Structures
ASTM C913	Precast Concrete, Water, and Wastewater Structures
ACI 301	Specifications for Structural Concrete Buildings
ACI 315	Details and Detailing of Concrete Reinforcement
ACI 315R	Manual of Engineering and Placing Drawings for Reinforced Concrete Structures
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Environmental Engineering Concrete Structures
CRSI 63	Recommended Practice for Placing Reinforcing Bars

1.04 DESIGN

A. All vaults shall be designed by a licensed professional engineer registered in the State of Arizona, and engaged by the manufacturer. All dead loads, live loads, flotation, erection, temperature and anchorage stresses shall be considered.

B. The calculations and drawings shall be prepared in a neat and legible manner, sealed by the licensed Professional Engineer performing the calculations.

C. The sealed calculations shall include a summary page to list all design loads, material specifications, and design criterion used in the calculations.

D. For design, groundwater shall be assumed at the top of the vault and the design shall provide for a 125 percent factor of safety against floatation.

E. Vaults shall be designed for H-20 wheel load on top slab and hatches. Structural calculations shall demonstrate adequate strength to resist in service and installation loadings including:
   1. AASHTO H20 wheel loading with applicable impact factors in accordance with ASTM C857.
   2. Surcharge load should be the weight of a minimum of 2 ft of embankment.
   3. Lateral earth pressures. Soil properties should follow the geotechnical engineering study report and its amendments.
   4. Any loads imposed by the supported pipeline and appurtenances.

1.05 SUBMITTALS

A. Submit evidence that shows current PCI, NPCA, and/or Arizona DOT certification.

B. Submit shop drawings of wall sections and bases proposed for this project, include joint design and related details for field assembly as applicable.

C. Submit certification of conformance with Contract Documents and ASTM C478, C858 & C913.

D. Submit catalog cut and installation details for aluminum hatches with fall protection grates, and ladders with safety devices

E. Submit catalog cut for epoxy coating system used at interior surfaces and waterproofing system used on exterior surfaces.

F. Under a separate submittal, provide two file copies of calculations for each vault indicating all loads and load combinations. Other than the summary page, calculations will not be reviewed; calculations will not be returned to Contractor.

1.06 QUALITY ASSURANCE

A. Manufacturer shall be a PCI, NPCA, and/or Arizona DOT-certified plant for production of precast vaults as specified herein.

B. Aggregate used in producing concrete shall be from Arizona DOT approved sources.

1.07 QUALITY CONTROL INSPECTION

A. The quality of all materials, the process of manufacture and the finished sections shall be subject to inspection by Engineer. Such inspection may be made at the place of manufacture and/or at the Site after delivery.

B. All sections shall be inspected for general appearance, dimensions, soundness, etc. The surface shall be dense, close-textured and free of honeycomb, cracks, roughness, exposure of reinforcement, damaged joints, or other irregularities.

C. All sections which have been damaged after delivery will be rejected, or if already installed, shall be repaired or removed and replaced entirely at Contractor's expense.

D. Rejected sections shall be tagged as such, segregated from other sections, and removed from the Site.

PART 2 PRODUCTS

2.01 CONCRETE

A. Minimum 28-Day Compressive Strength - 4500 psi.

2.02 REINFORCEMENT

A. Reference Section 03 20 00.

2.03 PRECAST OR CAST-IN-PLACE CONCRETE BASES

A. Design and manufacture of precast concrete bases shall conform to the requirements of this section and ASTM C478, C858 & C913. Cast-in-place concrete bases shall conform to Section 03 11 00 and Section 03 30 00.

B. Bases shall conform to the dimensions indicated on the Drawings or as required by design. The horizontal joint at the top of the base shall be compatible with that of the precast wall section.

C. Sumps shall be field constructed where shown on the Drawings. Walking surfaces shall be sloped to the sump, have a non-slip broom finish, and be sealed with a penetrating concrete sealer. Minimum concrete fill thickness at sumps shall be two inches.

2.04 PRECAST CONCRETE WALLS

A. Design and manufacture of precast concrete walls shall conform to the requirements of this section and ASTM C478, C858 & C913.

B. All tongue-and-groove joints in the precast wall, including the joint at the top of the base, shall be made up using gaskets.

C. The precast sections shall be provided with a special groove to receive and hold the gasket in position during joint assembly.

D. After joint assembly, the gap between sections shall be packed on the inside and outside with "Masterflow 713" by Master Builder; "Five Star Grout" by U.S. Grout Corp.; or equal, and shall be troweled smooth so that no projections remain on the inside. There shall be concrete to concrete bearing between the various sections. The gasket shall not support the weight of the section.

2.05 PRECAST CONCRETE SLAB TOPS

A. Precast reinforced concrete slab tops shall be manufactured in accordance with ASTM C478, C858 & C913. Openings and frames shall be provided for hatches where shown on the Drawings. Slab tops shall be set in a full bed of mortar.

B. Slab tops shall be crowned or sloped to drain, minimum 1/4 inch per foot.

C. Concrete slab tops shall receive a non-slip broom finish and a penetrating concrete sealer per Section 03 30 00.

2.06 GRATING TOPS

A. Where grated tops are shown on the Drawings, the Contractor shall supply fabricated grating frames to the precast manufacturer and coordinate the grating installation for a complete Project.

2.07 PIPE SEALS

A. Where polyethylene, plastic or PVC pipe is utilized, connections between vault and pipes shall be made with flexible rubber sleeves with stainless steel straps and bolts. Provide an elastomeric waterstop gasket where sleeve sizes are not commercially available.

B. The annular space around the pipe wall or sleeve shall be packed with “Masterflow 713” by Master Builders, “Five Star Grout” by U.S. Grout Corp.; or equal. Before the grout has set, Contractor shall recheck invert elevations of the pipe.

C. For steel or ductile iron pipe, provide a pipe sleeve sized to accept the pipe plus a modular mechanical seal such as Link Seal or equal.

2.08 HATCHES

A. Hatches shall be of the size and type shown on the Drawings and as described in Section 08 31 20.
   1. Aluminum single leaf, watertight gasketed floor hatch. Floor hatch shall be furnished with flush stainless steel hinges, aluminum stiffeners, and lockable slam latch. Hatches shall have extended aluminum frame to match concrete thickness with continuous anchor and shall be constructed of 1/4 inch minimum aluminum diamond pattern plate design.
   2. Hatches shall be provided with an auto-lock, hold-open device and torsion spring assembly. All hardware, including all parts of the latch and lifting mechanism assemblies, hold-open arms and guides, and all brackets, hinges, pins and fasteners shall be stainless steel or bronze.
   3. The hatches shall be designed for an H-20 wheel load. A 1-inch drain coupling shall be provided in hatch frame. Contractor to extend drain to exterior of structure or to sump pit at vaults intended to remain dry.
   4. At all hatches, provide a hinged aluminum grate fall-through protection system.
   5. Aluminum hatches shall be Bilco “PCM” or as manufactured by Washington Aluminum Company or equal.

2.09 LADDER

A. Where shown on the Drawings, provide ladders as specified in Section 05 50 00.

B. Where shown on Drawings, provide ladder rungs made of cast iron or polypropylene with steel reinforcement. Rungs shall be either cast in place or drilled and adhesive grouted in the shop. Rungs are equally spaced at a maximum 12-inch spacing from the top of the base slab to the top of the top slab.

C. Install ladder rungs so that the distance from the rungs to the finished wall is 7 inches.

D. Provide stainless steel ladder access safety post as specified in Section 05 50 00 by Bilco, U.S.F. Fabrications, or equal.

2.10 OPENINGS AND INSERTS

A. All openings required in the concrete shall be reinforced with additional diagonal bars tied to each layer of wall or slab reinforcement.

B. Any required pipe sleeves, inserts, and wall openings shall be coordinated with mechanical requirements prior to casting the units.

2.11 WATERPROOFING

A. Around the exterior of all wall joints, apply the “Bituthene” primer and membrane waterproofing system by W.R. Grace Company, or equal.

B. Exterior wall surfaces shall be waterproofed using manufacturer’s standard two-coat system, specifically designed to waterproof the exterior of concrete surfaces in a below-grade submerged condition.

C. For the top slab and above-grade exposed side walls, the concrete shall be sealed with two coats of a penetrating concrete slab sealer per Section 03 30 00.

2.12 EPOXY COATING

A. The interior surface of the wet well shall receive a factory applied epoxy coating. Apply at wall surfaces (full height) and ceiling.

B. Surfaces shall be abrasive blasted and allowed to cure a minimum of 28 days prior to application of epoxy coating system. Follow manufacture’s instructions for primer, application temperatures, etc. Use Sika Corporation “Sikagard 62”, Euclid Chemical Company “Duraltex 1707”, or equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that subgrade elevations for vault base is correct, excavation is dewatered, and subgrade is pre-compacted.

B. Verify that rejected units have been removed from Site.

3.02 PREPARATION

A. Provide foundation mat of run-of-crusher stone to support base. Mat shall be 6 inches minimum depth and shall bear on sound undisturbed earth; excavate and remove subgrade material as necessary to reach sound subgrade.

B. Stone foundation mat shall be a minimum of 1 foot greater than the footprint of the vault base, and shall be compacted to a uniform, level surface.

3.03 INSTALLATION

A. Vault shall be accurately located and uniformly supported on the foundation mat in a level position.

B. Install wall sections in properly oriented position; follow manufacturer's instructions for joining together each section using the gaskets. Pack joints with grout.

C. Units shall be laid-up plumb and level.

D. Contractor is responsible for the integrity of all materials and protection against flotation during the installation and backfilling process.

3.04 COATINGS

A. All exterior below-grade wall joints shall be sealed using a membrane waterproofing system. Next, all below-grade wall surfaces shall be waterproofed, applied per manufacturer's instructions.

B. After installation is complete, the cover slab and interior walking surfaces shall be sealed as specified above.

C. After installation of mechanical equipment, provide touch-up painting of damaged epoxy wall finish.

3.05 BACKFILLING

A. Backfill using well compacted structural fill material, being careful to not damage exterior waterproof coating while providing full support under connecting pipes using compacted bedding material.

B. During the one year warranty period, all visible leaks shall be sealed in an approved manner.

3.06 SCHEDULE OF VAULTS

Vault Identification	Reference Drawing
4 nos. Power/Control Vault	Volume 2 - E-00-101 & E-00-102
4 nos. Instrumentation Vault	Volume 2 - E-00-101 & E-00-102
Fiber Optic Pull Box	Volume 2 - E-00-101
Meter and Tank Electronic Transmitter Vault.	Volume 2 - C-00-401

Valve Vault	Volume 2 - M-70-101
2 nos. Power/Control Vault	Volume 1 - E-100
2 nos. Instrumentation Vault	Volume 1 - E-100

END OF SECTION

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SECTION 03 60 00

GROUTING

PART 1 GENERAL

1.01 DESCRIPTION

A. Section includes: Grout for column base plates, other structural supports, equipment bases, reinforcing bar dowels, surface repair, grout toppings, patching of fresh concrete, and uses other than masonry. Grout for masonry is specified in Section 04 22 00. Adhesive anchor bolt grouting is specified in Section 05 05 20. Topping concrete over precast elements and clarifier topping concrete is specified in Section 03 30 00.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 03 30 00 Cast-In-Place Concrete
   2. Section 04 22 00 Concrete Unit Masonry
   3. Section 05 05 20 Anchor Bolts
   4. Section 43 05 13 Rigid Equipment Mounts

1.03 REFERENCES:

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM C109	Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 inch or 50 mm Cube Specimens)
ASTM C230	Flow Table for Use in Tests of Hydraulic Cement
ASTM C307	Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings
ASTM C939	Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C531	Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C579	Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings and Polymer Concretes
ASTM C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear
ASTM C942	Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C1107	Packaged Dry, Hydraulic-Cement Grout (Non-shrink)

Reference	Title
ASTM C1181	Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts
ASTM E329	Agencies Engaged in Construction Inspection, Testing, or Special Inspection
COE CRD-C611	Flow of Grout for Preplaced Aggregate Concrete
COE CRD-C621	Non-shrink Grout
IBC	International Building Code

1.04 SUBMITTALS

A. Action Submittals
   1. Procedure: Section 01 33 00:
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. Complete product literature, including mixing, handling and placement instructions for the following: Cementitious non-shrink grout, epoxy grout, adhesive for reinforcing bar dowel grouting, concrete repair mortar, and prepackaged cement grout products to be used on the project.
   5. Mix design for cement grout that is not prepackaged, including product data for aggregates and cement in accordance with Section 03 30 00.
   6. Current ICC Evaluation Service reports for adhesives used for reinforcing dowels.
   7. Installer certification in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program for installers of horizontal or upwardly inclined reinforcing bar dowels grouted using adhesive.
   8. Certified test results verifying the compressive strength, shrinkage and expansion requirements specified herein.

1.05 QUALITY ASSURANCE

A. Quality Control by Owner
   1. The Owner will provide the services of a qualified Special Inspector in accordance with Section 01 45 23.

2. Adhesive anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads shall be continuously inspected during installation by a Special Inspector.
    a. The Special Inspector shall furnish a report to the Engineer, Owner's Representative and Building Official that the work covered by the report has been performed and that the materials used and the installation procedures used conform with the approved Project Manual and the Manufacturer's Printed Installation Instructions (MPII).

B. Quality Control by Contractor
    1. Provide the services of an independent testing laboratory which complies with the requirements of ASTM E329 if a product other than those listed below is proposed and test data is not available from the supplier to demonstrate equivalence to the specified grout. The testing laboratory shall sample and test the proposed grout materials. Costs of testing laboratory services shall be borne by the Contractor.

C. Certifications
    1. Installer certification shall be in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program for installers of horizontal or upwardly inclined reinforcing bar dowels grouted using adhesive.

D. Compression test specimens will be taken during construction from the first placement of each type of grout and at intervals thereafter as selected by the Engineer to insure continued compliance with these Specifications.
    1. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C579, Method B, at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days and any other time period as appropriate.
    2. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C109 at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days, 28 days and any additional time period as appropriate.

E. Manufacturer Qualifications
    1. Manufacturer shall have a minimum of five years experience of producing products substantially similar to that required and shall be able to submit documentation of at least five satisfactory installations that have been in successful operation for at least five years each.
    2. When required, provide services of manufacturer's full-time employee, factory-trained in handling, use, and installing the products required, with at least five years of experience in field applications of the products required.

PART 2 PRODUCTS

2.01 CEMENTITIOUS NON-SHRINK GROUT

A. The grout material shall be an approved ready to use mixture requiring only water for use at the job site. The 2-inch cubes shall have a minimum compressive strength of 3,000 psi at 7 days and 7,000 psi at 28 days.

B. Cementitious non-shrink non-metallic aggregate grout shall be:
   1. BASF, Masterflow 928
   2. Euclid Chemical Company, Hi-Flow Grout
   3. Five Star Products, Inc., Five Star Grout
   4. Sika Corporation, SikaGrout 212
   5. Approved Equal

C. Non-shrink grout shall conform to CRD-C 621 and ASTM C1107, Grade B or C when tested at a maximum fluid consistency of 30 seconds per ASTM C939 at temperature extremes of 45 degrees Fahrenheit and 90 degrees Fahrenheit and an extended working time of 15 minutes.

D. Fluid grout shall pass through the flow cone, with continuous flow, one hour after mixing.

2.02 EPOXY GROUT FOR EQUIPMENT MOUNTING:

A. Epoxy grout shall be a pourable, non-shrink, 100-percent solids system.

B. Epoxy grout for equipment mounting shall be a non-cementitious, resin based, multi-component formulation. Epoxy grout shall be flowable, with shrinkage minimized to achieve minimum 98% effective bearing area. Epoxy grout shall be:
   1. BASF, Masterflow 648
   2. Euclid Chemical Company, E3-G
   3. Sika Corporation, Sikadur 42
   4. Approved Equal.

C. The following properties shall be attained with the minimum quantity of aggregate allowed by epoxy grout manufacturer.
   1. Length change after hardening shall be less than 0.0006-inch per inch and coefficient of thermal expansion shall be less than 0.00003-inch per inch per degree F when tested in accordance with ASTM C531.
   2. Compressive creep at one year shall be less than 0.001-inch per inch when tested under a 400-psi constant load at 140 degrees F in accordance with ASTM C1181.
   3. Minimum seven-day compressive strength shall be 14,000 psi when tested in accordance with ASTM C579
   4. Grout shall be capable of maintaining at least a flowable consistency for minimum of 30 minutes at 70 degrees F.
   5. Shear bond strength to portland cement concrete shall be greater than shear strength of concrete when tested in accordance with ASTM C882/C882M.

2.03 ADHESIVE FOR GROUTING REINFORCING BAR DOWELS

A. Adhesive for setting dowels in concrete shall be an injectable two-component epoxy adhesive. Adhesive shall be approved for the intended use per the product ICC Report. Adhesive shall be:
   1. Hilti, HIT-RE 500v3
   2. Simpson Strong Tie, SET XP

3. Approved Equal (equivalent product must have ICC approval for use in cracked concrete in areas with high seismic risk).

B. Adhesive for setting dowels in concrete masonry shall be an injectable two-component epoxy adhesive. Adhesive shall be approved for the intended use per the product ICC Report or IAPMO Report. Adhesive shall be:
   1. Hilti, HIT-HY 270
   2. Simpson Strong Tie, SET XP
   3. Approved Equal acceptable per ICC Report or IAPMO Report for resisting earthquake loads

2.04 CONCRETE REPAIR MORTAR

A. Horizontal Applications: Repair mortars shall be:
   1. BASF, MasterEmaco S 466CI
   2. Sika Corporation, SikaTop 111 Plus
   3. Approved Equal

B. Vertical and Overhead Applications: Repair mortars shall be:
   1. BASF, MasterEmaco 1500HCR Vertical Overhead
   2. Sika Corporation, SikaTop 123 Plus
   3. Approved Equal

2.05 CEMENT GROUT

A. Cement grout shall be comprised of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed in accordance with this Section.
   1. Minimum Compressive Strength: 4,500 psi at 28 days.
   2. Maximum Water Cement Ratio: 0.42 by weight.
   3. Coarse Aggregate: ASTM C33/C33M, No. 8 size.
   4. Fine Aggregate: ASTM C33/C33M, approximately 60 percent by weight of total aggregate.
   5. Air Content: Five percent (plus or minus one percent).
   6. Minimum Cement Content: 564 pounds per cubic yard.
   7. Slump for grout fill shall be adjusted to match placing and finishing conditions, and shall not exceed four inches.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and accept existing conditions before beginning work.

3.02 CEMENTITIOUS NONSHRINK GROUT

A. Non-shrink, cementitious, nonmetallic aggregate grout shall be used for column base plates, structural bearing plates, and all locations where the general term “non-shrink grout” is indicated on the Drawings. Use of this grout to support the bearing surfaces of machinery shall be as specified in Section 43 05 13 or as detailed on the Drawings for specific locations or pieces of equipment. If guidance is not provided in locations noted above, use of non-shrink grout for equipment mounting shall be limited to equipment less than 25 horsepower or 750 pounds. Grout shall be placed and cured in accordance with the manufacturer's instructions.

B. Non-shrink cementitious grout shall not be used as a surface patch or topping. Non-shrink cementitious grout must be used in confined applications only.

3.03 EPOXY GROUT FOR EQUIPMENT MOUNTING

A. Prepare concrete surfaces of equipment pads as indicated in details on the Drawings and as required by the epoxy grout manufacturer. Epoxy grout for equipment mounting shall be placed and cured in accordance with the requirements of Section 43 05 13, details on the Drawings, and in conformance with manufacturer’s recommendations.

3.04 ADHESIVE FOR GROUTING REINFORCING BAR DOWELS

A. Follow manufacturer’s instructions.

3.05 CONCRETE REPAIR MORTAR

A. Concrete repair materials and procedures shall be submitted for review to the Owner’s Representative and shall be accepted prior to commencement of the repair work.

B. Follow all manufacturer's instructions, including those for minimum and maximum application thickness, surface preparation and curing. Add aggregate as required per manufacturer's recommendations. Any deviations from the manufacturer's instructions shall be submitted for review to the Owner’s Representative and shall be accepted prior to commencement of the work.

3.06 CEMENT GROUT

A. Cement grout shall be used for grout toppings less than four inches thick and for patching of fresh concrete.

B. Grouting shall comply with temperature and weather limitations in Section 03 30 00, Cast-In-Place Concrete.

C. Cure grout in accordance with grout manufacturer’s instructions for prepackaged grout and Section 03 30 00, Cast-In-Place Concrete, for non-prepackaged cement grout.

END OF SECTION

SECTION 04 22 00

CONCRETE UNIT MASONRY

PART 1 GENERAL

1.01 DESCRIPTION

A. Section includes: Reinforced concrete masonry constructed from concrete masonry units, reinforcing steel, mortar, and grout. Reference 04 26 13 for masonry veneer including anchorage.

B. Concrete unit masonry materials and construction: Conform to TMS 602, except where noted otherwise in this Section.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 03 20 00 Concrete Reinforcing.
   2. Section 04 26 13 Masonry Veneer.
   3. Section 07 19 00 Water Repellents.

1.03 REFERENCES:

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ACI SP-66	ACI Detailing Manual
TMS 602	Specification for Masonry Structures
ASTM A153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A580	Stainless Steel Wire
ASTM A951	Steel Wire for Masonry Joint Reinforcement
ASTM A1064	Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C90	Loadbearing Concrete Masonry Units
ASTM C144	Aggregate for Masonry Mortar
ASTM C150	Portland Cement
ASTM C207	Hydrated Lime for Masonry Purposes
ASTM C270	Mortar for Unit Masonry
ASTM C404	Aggregates for Masonry Grout
ASTM C476	Grout for Masonry
ASTM C979	Pigments for Integrally Colored Concrete
ASTM C1314	Compressive Strength of Masonry Prisms
IBC	International Building Code

1.04 SUBMITTALS

A. Action Submittals
   1. Procedure: Section 01 33 00:
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. Mix design for grout.
   5. Product Data
      a. Masonry unit certificates: Show compliance with the specifications for each type of masonry unit.
      b. Reinforcing certificates: Showing compliance with the specifications for reinforcing steel as specified herein and in Section 03 20 00.
      c. Manufacturer's data and descriptive literature for each type of masonry accessory (anchors, wall ties, positioning devices, etc.), joint reinforcement, premixed mortar, grout admixtures, and flashing. Clearly mark the data to indicate which type, size, or item will be provided.
   6. Shop Drawings
      a. Reinforcing Steel: Detail bending and placement of masonry reinforcing bars. Comply with ACI SP-66.
      b. Masonry Units: Details of all types of CMU units including, but not limited to, corners, jamb units, lintels and bond beams.
      c. Anchors, wall ties, positioning devices, and other accessories, including locations.
   7. Samples for Verification: Full size units for each different exposed masonry unit.
   8. Test Reports
      a. Provide tests from an independent testing agency.
      b. Concrete Masonry Compressive Strength (f'm): Prism tests in accordance with ASTM C1314.
      c. Material Test Reports: Masonry units and grout.

1.05 QUALITY ASSURANCE

A. Quality Control by Owner
   1. The Owner will provide the services of a qualified Special Inspector in accordance with IBC and Section 01 45 23.

B. Sample Panel: Construct a sample masonry panel for each type of masonry, approximately 6 feet long by 4 feet high, on site for approval by the Owner. Each panel shall show the workmanship, coursing, bond, anchors, tooling of joints, range of color, texture of masonry, and mortar color. Finished work shall match the approved sample panel.

C. Do not change source or supply of materials after the work has started.

D. Determine compressive strength of concrete masonry (f'm) by the prism test method in accordance with TMS 602 and ASTM C1314. Use the same materials and workmanship to construct the prisms as those to be used in the structures. Submit prism test results verifying required compressive strength (f'm) prior to beginning construction of masonry walls.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver cementitious materials to the site in unbroken containers, plainly marked and labeled with manufacturers' names and brands, stored in dry, weather tight enclosures to prevent entry of foreign materials and damage by water or dampness. Store masonry units off the ground and handle with care to avoid chipping and breakage. Protect materials from damage and, except for sand, keep dry until used. Cover sand to prevent intrusion of water and foreign materials and to prevent drying. Do not use materials containing frost or ice.

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS

A. General: Provide air, water, or steam cured concrete masonry units with modular dimensions. Texture and color masonry units per the Drawings and Specifications.

B. Concrete Masonry Units (CMU): For hollow concrete masonry units at both load-bearing and non-load-bearing walls, conform to ASTM C90, medium weight, with concrete masonry unit compressive strength as required to result in a concrete masonry compressive strength (f'm) of 2,000 psi. Concrete masonry units shall contain "DRY BLOCK" admixture by WR Grace Co. or "RainBloc" admixture by ACM Chemistries, Inc., amount per manufacturer's recommendation.

C. CMU shall be colored as spec 04 26 13. Use iron oxide based colorant conforming to ASTM C979/C979M. Match pattern and texture with veneer specification.

D. Special Shapes: Provide special shapes such as closures, header units, and jamb units as necessary to complete the work. Conform to the requirements for the units with which they are used.

2.02 MORTAR:

A. Mortar: Conform to ASTM C270, Type S.

B. Cement: Portland cement conforming to ASTM C150, Type II, low alkali containing less than 0.60 percent alkalis.

C. Hydrated Lime: Conform to ASTM C207, Type S.

D. Masonry Cement: Do not use masonry cement.

E. Sand for Masonry Mortar: Conform to ASTM C144.

F. Water: Clean, potable, and free from substances which could adversely affect the mortar.

G. Waterproofing Compound: Mortar shall contain “DRY BLOCK” admixture by WR Grace Co. or “RainBloc” admixture by ACM Chemistries, Inc., amount per manufacturer’s recommendation.

H. Colored Mortar: Provide colored mortar to match the masonry units as spec 04 26 13. Use iron oxide based colorant conforming to ASTM C979/C979M.

I. Admixtures: Admixtures may be used in mortar to retard curing and improve workability, provided that the admixture does not adversely affect bonding or compressive strength.

J. Mortar air content shall not exceed 12 percent. Do not use air-entraining admixtures.

2.03 GROUT

A. General: Conform to ASTM C476. Use Type II cement, minimum 28-day compressive strength of 2,000 psi or specified concrete masonry compressive strength (f’m), whichever is greater. Grout shall have sufficient water added to produce a consistency for pouring without segregation.

B. Aggregate: Conform to ASTM C404.

C. Fine Grout: Composed of one part cement, not more than 1/10 part lime, and 2 1/4 to 3 parts (by volume) fine aggregate.

D. Coarse Grout: Composed of one part cement, not more than 1/10 part lime, 2 to 3 parts (by volume) fine aggregate, and not more than 2 parts (by volume) coarse aggregate.

2.04 REINFORCING

A. Reinforcing Bars: See Section 03 20 00 Concrete Reinforcing.

B. Joint Reinforcing: Ladder type wire reinforcing with 9-gauge side and cross wires conforming to ASTM A951 and ASTM A1064, and hot-dip galvanized per ASTM A153 Class B-2.

2.05 ACCESSORIES

A. Material for anchors, wall ties, and other accessories should follow spec 04 26 13.

B. Seismic Adjustable Ladder Style Horizontal Joint Reinforcing should follow spec 04 26 13.

C. Through-Wall Flashing should follow spec 04 26 13.

2.06 WATER REPELLENT

A. Water repellent coating on masonry wall should follow spec 07 19 00.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and accept existing conditions before beginning work.

3.02 PREPARATION

A. Construct straight and level foundations for masonry work. Provide surfaces that are clean and free of laitance or foreign materials for bonding with masonry. Reinforcing dowels shall be in accordance with Drawings. Coordinate the placement and location of anchor ties, inserts, and other embedded items in concrete or other adjoining work to suit the masonry work.

3.03 PROTECTION:

A. Protect exposed surfaces from mortar and other stains. When mortar joints are tooled, remove mortar from exposed surfaces with fiber brushes and wooden paddles. Protect base of walls from splash stains.

B. Do not apply uniform loads for at least 48 hours or concentrated loads for at least 72 hours after masonry is constructed.

C. Provide temporary bracing as required to prevent damage during construction.

D. Protect masonry construction to prevent efflorescence. Take measures to eliminate moisture from entering walls that have not received parapet coping or coatings. Remove all efflorescence prior to applying water repellents.

3.04 WORKMANSHIP

A. Construct masonry level and plumb. Use story poles or gage rods throughout the work. Changes in coursing or bonding after the work is started will not be permitted; neither will carrying one section of the walls up in advance of the others be permitted. Step back unfinished work for joining with new work; toothing will not be permitted. Check with an instrument heights of masonry at each floor and at sills and heads of openings to maintain the level of the walls. Build in door and window frames, louvered openings, anchors, pipes, ducts, and conduits as the masonry work progresses. Fill solidly with mortar spaces around metal door frames. Perform drilling, cutting, fitting, and patching to accommodate the work of others. Cut masonry with masonry saws for exposed work. Place in position structural steelwork, bolts, anchors, inserts, plugs, ties, lintels, and miscellaneous metalwork as the work progresses. Provide chases of approved dimensions for pipes and other purposes. Cover tops of exposed walls and partitions not being worked on with a waterproof membrane secured in place and extended down at least 2 feet on both sides.

3.05 MORTAR MIXING

A. Measure mortar materials in 1 cubic foot containers to maintain control and accuracy of proportions; measuring materials with shovels is not permitted. Mix mortar in a mechanical batch mixer for not less than 3 nor more than 5 minutes after all ingredients have been added to produce a uniform mixture. Add water gradually as required to produce a workable consistency. Mortar not formulated to include retarding admixtures, which has not been placed in final position within 2-1/2 hours after the initial mixing, shall not be retempered and used. Use of antifreeze compounds, salts, or other substances to lower the freezing point of mortar is prohibited.

B. Mix mortar in accordance with ASTM C270 to obtain type mortar specified. Where colored mortars are required, pigments may be added at the site or provided as part of prepackaged mortar mix.

3.06 MORTAR JOINTS

A. Construct mortar joints with uniform thickness of 3/8-inch unless otherwise specified. Tool exposed joints slightly concave with a round or other suitable jointer when the mortar is thumbprint hard except where otherwise required to match existing construction. For horizontal joints, make jointers at least 16 inches long. Jointers shall be slightly larger than the width of the joint so that complete contact is made along the edges of the units, compressing and sealing the surface of the joint. Strike flush joints that will not be exposed. Tool vertical joints first. Construct horizontal joints level; construct vertical joints plumb and in alignment from top to bottom of wall within a tolerance of plus or minus 1/2 inch in 40 feet.

3.07 TOLERANCES

A. Construct masonry work within the following limits:
   1. Pilasters and Columns: 1/4 inch from true line.
   2. Face of Concrete Masonry Unit: 1/16 inch from face of adjacent unit.
   3. Variation from True Plane: 1/4 inch in 10 feet and 1/2 inch maximum in 20 feet or more.
   4. Variation from Plumb: 1/4 inch in each story, noncumulative and 1/2 inch maximum in two stories or more.
   5. Variation from Level: 1/8 inch in 3 feet, 1/4 inch in 10 feet, and 1/2 inch maximum.
   6. Variation in Wall Thickness: Plus or minus 1/4 inch.

3.08 CONCRETE MASONRY UNIT WORK

A. General: Lay the first course in a full bed of mortar for the full width of the unit. Lay succeeding courses in running bond unless otherwise specified. Form bed-joints by applying the mortar to the entire top surfaces of the inner and outer face shells and to head joints by applying the mortar for a width of 1 inch to the ends of the adjoining units. Apply mortar of such thickness that it will be forced out of the joints as the units are placed in position. Do not dampen concrete masonry units before or during laying.

B. Fill all cores solid with grout. Lay units in such a manner as to preserve the unobstructed vertical continuity of cores to be filled. Remove mortar fins protruding from joints before grout is placed. Minimum clear dimensions of vertical cores shall be 2 by 3 inches. Position and hold reinforcing before placing grout by tying or by using bar positioners at maximum 8-foot intervals. Use a vibrator to consolidate the grout. Minimum clear distance between masonry and vertical reinforcement shall be 1/2 inch. Form splices by lapping bars as shown on design drawings.

3.09 BONDING AND ANCHORING

A. Unless otherwise specified, extend partitions from the floor to the bottom of the construction above. Structurally bond and anchor walls and partitions to each other and to concrete walls and beams. Unless otherwise specified, non-load-bearing partitions and interior walls shall be securely anchored to the construction above in a manner that provides lateral stability while permitting unrestricted deflection of construction above. Embed anchors completely in mortar joints.

B. In addition, bonding and anchoring shall comply with the following procedures unless otherwise specified.
   1. Use running bond throughout.
   2. At corners of load-bearing walls, provide a true masonry bond (true corner blocks finished on both face and end) in each course.
   3. At intersections of load-bearing walls, provide a true masonry bond in each course, or anchor with rigid steel anchors not more than 2 feet apart vertically.
   4. At intersections of non-load-bearing partitions with other walls or partitions, tie with wire mesh ties at vertical intervals of not more than 2 feet or with masonry bonding in alternate courses.
   5. At masonry walls facing or abutting new concrete members, anchor masonry to the concrete with dovetail or wire-type anchors inserted in slots or inserts built into the concrete. To anchor masonry walls to existing concrete members, use corrugated metal ties anchored by drive pins to the concrete. Locate anchors not more than 18 inches o.c. vertically and not more than 24 inches o.c. horizontally.

3.10 HORIZONTAL JOINT REINFORCEMENT

A. Unless otherwise specified, joint reinforcement shall be provided at 16-inch spacing in masonry walls. Joint reinforcement shall be continuous except at control joints and expansion joints. Joint reinforcement above and below openings shall extend not less than 24 inches beyond each side of openings. Joint reinforcement shall be provided in the longest available lengths, utilizing the minimum number of splices. Welded L-shaped assemblies and welded T-shaped assemblies to match the straight reinforcement shall be provided at corners and intersections of walls.

3.11 CONCRETE MASONRY UNIT LINTELS AND BOND BEAMS

A. Fill special units, lintels, and bond beams solidly with grout and reinforce as shown on Drawings. Terminate bond beams and reinforcing on each side of expansion joints. Concrete masonry units used for lintels and bond beams shall have exposed surfaces of the same material and texture as the adjoining masonry units. Produce bond beam units from standard vertically-voided units with precut knock-out cross walls. Lintels shall be straight and true and shall have at least 8 inches of bearing at each end. Keep shoring in place for at least 7 days following construction of lintel beams.

3.12 GROUT

A. General: Provide fine grout in grout spaces which are less than 2 inches in any horizontal dimension after deducting the thickness of horizontal reinforcing or in which clearance between reinforcing and masonry is less than ¾ inch. Provide coarse grout in grout spaces which are 2 inches or greater in all horizontal dimensions after deducting the thickness of horizontal reinforcing provided the clearance between reinforcing and masonry is not less than 3/4 inch. For a coarse grout pour over 6 feet high, increase grout space minimum horizontal dimension to 3 inches.

B. Placement: Place grout within 1 ½ hours from introducing water into the mix and prior to initial set. Protect sills, ledges, offsets, and other surfaces from grout droppings. Prior to grouting, clean the grout space so that all spaces to be filled with grout do not contain mortar projections greater than 1/2 inch, mortar droppings, or other foreign material. Grout shall be well mixed to prevent segregation, shall be sufficiently fluid to flow into joints and around reinforcing without leaving voids, and shall be placed by pumping or pouring from buckets equipped with spouts. Place grout in a continuous pour in grout lifts not exceeding 5 feet 4 inches. Do not exceed the maximum grout pour height specified in TMS 602 based on the grout type and space requirements. At grout pours exceeding 5 feet 4 inches, provide cleanouts in the bottom course at every vertical bar, spaced not more than 32 inches on center for solid grout masonry. To form a grout key, end pours 1-1/2 inches below the top of masonry units in top course, except at the finish course. Agitate grout thoroughly to eliminate voids. Remove and lay masonry displaced by grouting operation in alignment with fresh mortar.

3.13 CONTROL JOINTS

A. Unless shown otherwise on the design drawings, provide control joints in reinforced concrete masonry walls at a spacing equal to 1.5 times the wall height, not to exceed 25 feet. Control joints shall be located a minimum of 32 inches beyond the face of an opening. Control joint detail shall be as shown on the Drawings.

3.14 CLEANING

A. Protect work which may be damaged, stained, or discolored during cleaning operations.

B. Clean exposed masonry surfaces with clear water and stiff fiber brushes and rinse with clear water. Where stains, mortar, or other soil remain, continue scrubbing with warm water and detergent. Immediately after cleaning, rinse each area thoroughly with clear water. Restore damaged, stained, and discolored work to original condition or replace with new work.

3.15 PROJECT CONDITIONS

A. Cold Weather Construction: Follow procedures specified in TMS 602.

B. Hot Weather Construction: Follow procedures specified in TMS 602.

3.16 WATER REPELLENT

A. Apply water repellent specified in this Section to the masonry wall faces exposed to weather per manufacturer's recommendations unless a coating is specified in Section 09 90 00. If a coating is specified in Section 09 90 00, do not apply the water repellent specified in this section.

END OF SECTION

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SECTION 04 23 00

GLASS UNIT MASONRY

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Glass block set in mortar.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: Glass-block units.

PART 2 PRODUCTS

2.01 GLASS BLOCK

A. Solid Glass Block: Colorless, transparent, solid glass blocks with stippled faces and manufacturer's standard edge coating.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Seves Glass Block, Vistabrik Stipple, 8”x8”x3” solid glass block, or comparable product by another manufacturer.

2.02 MORTAR MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or Type II. Provide natural color or white cement as required to produce mortar color indicated.
   1. Where joints are indicated to be raked out and pointed, gray cement may be used for setting mortar.

B. Hydrated Lime: ASTM C207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Masonry Cement: ASTM C91/C91M.

E. Aggregate: ASTM C144, with 100 percent passing No. 8 sieve.
   1. White Aggregates: Natural white sand or crushed white stone.

F. Water-Repellent Admixture: Dry mixture of stearates, water-reducing agents, and fine aggregates intended to reduce capillarity in mortar.

G. Water: Potable.

2.03 GLASS UNIT MASONRY ACCESSORIES

A. Panel Reinforcement: Ladder-type units, butt welded, not lapped and welded; complying with ASTM A951/A951M in straight lengths of not less than 10 feet, and as follows:
   1. Exterior Walls: Stainless-steel wire.
   2. Wire Size: W1.7 or 0.148-inch diameter.
   3. Width: 1-5/8 inches.
   4. Spacing of Cross Rods: Not more than 16 inches apart.

B. Panel Anchors: Glass-block manufacturer's standard perforated steel strips, 0.0359 inch by 1-3/4 inches wide by 24 inches long, hot-dip galvanized after fabrication to comply with ASTM A153/A153M.

C. Fasteners, General: Unless otherwise indicated, provide Type 304 or Type 316 stainless-steel fasteners at exterior walls and zinc-plated fasteners with coating complying with ASTM B633, Class Fe/Zn 5, at interior walls. Select fasteners for type, grade, and class required.

D. Asphalt Emulsion: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M or ASTM D1227.

E. Plastic-Foam Expansion Strips: Polyethylene foam complying with requirements of glass-block manufacturer; 3/8 inch thick by 2-1/2 inches wide.

F. Sealants: Manufacturer's standard elastomeric sealants of base polymer and characteristics indicated below that comply with applicable requirements in Section 079200 "Joint Sealants."
   1. Urethane, S, NS, 25, NT.

G. Sealant Accessories: Provide sealant accessories, including primers, bond-breaker tape, and cylindrical sealant backing, that comply with applicable requirements in Section 07 92 0 0 "Joint Sealants."

2.04 MORTAR MIXES

A. General: Do not use admixtures unless otherwise indicated.
   1. For mortar in exterior panels, use water-repellent admixture according to admixture manufacturer's written instructions.
   2. Limit cementitious materials in mortar to portland cement and lime.

B. Mortar for Glass Unit Masonry Assemblies: Comply with ASTM C270, Proportion Specification for Type S mortar.

PART 3 EXECUTION

3.01 INSTALLING GLASS BLOCK WITH MORTAR

A. Apply a heavy coat of asphalt emulsion to sill and adhere expansion strips to jambs and heads with asphalt emulsion. Allow asphalt emulsion to dry before placing mortar. Trim expansion strips to width required to fit glass block and to full lengths of heads and jambs.

B. Set glass block with completely filled bed and head joints, with no furrowing, accurately spaced and coordinated with other construction. Maintain 3/8-inch exposed joint widths unless otherwise indicated.

C. Install panel reinforcement in horizontal joints at spacing indicated and continuously from end to end of panels; comply with the following requirements:
   1. Vertical Spacing of Panel Reinforcement for Exterior Panels: Every other course but not more than 16 inches o.c., starting with first course above sill.
   2. Do not bridge expansion joints with panel reinforcement.
   3. Place panel reinforcement in joints immediately above and below all openings within glass unit masonry assemblies.
   4. Lap panel reinforcement not less than 6 inches if more than one length is necessary.

D. Install panel anchors at locations indicated and in same horizontal joints where panel reinforcement occurs. Extend panel anchors at least 12 inches into joints, and bend within expansion joints at edges of panels and across the head. Attach panel anchors as follows:

E. Use plastic spacers or temporary wedges in mortar joints to produce uniform joint widths and to prevent mortar from being squeezed out of joints.

F. Keep expansion joints free of mortar.

G. Rake out joints indicated to be pointed to a uniform depth sufficient to accommodate pointing material, but not less than joint width.
   1. Point joints at both faces of exterior and interior panels with sealant.

H. Point joints by filling with sealant to comply with requirements in Section 07 92 00 "Joint Sealants."

I. Install sealant at jambs, heads, mullions, and other locations indicated. Prepare joints, including installation of primer and bond-breaker tape or cylindrical sealant backing, and apply elastomeric sealants to comply with requirements in Section 07 92 00 "Joint Sealants."

3.02 CLEANING

A. Perform final cleaning of glass unit masonry assemblies when surface is not exposed to direct sunlight. Start at top of panel using generous amounts of clean water. Remove water with clean, dry, soft cloths; change cloths frequently to eliminate dried mortar particles and aggregate.

END OF SECTION

SECTION 04 26 13

MASONRY VENEER

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Concrete masonry units.
   2. Mortar materials.
   3. Ties and anchors.
   4. Embedded flashing.
   5. Accessories.
   6. Mortar mixes.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type and color of colored mortar.

1.03 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of product.

1.04 MOCKUPS

A. Sample Panels: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 01 45 00 "Contractor Quality Control" for mockups.
   1. Build sample panels for each type of exposed unit masonry construction in sizes approximately 48 inches long by 48 inches high by full thickness.

1.05 FIELD CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602.

B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602.

PART 2 PRODUCTS

2.01 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602, except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects will be exposed in the completed Work and will be within 20 ft. vertically and horizontally of a walking surface.

2.02 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
   1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

B. Decorative CMUs: ASTM C90, medium weight.
   1. Pattern and Texture: Standard pattern, split-face finish, Color A and Color C. Refer to Drawings.
   2. Pattern and Texture: Standard pattern, ground-face finish, Color B and Color D. Refer to Drawings.

2.03 MORTAR MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Davis Colors.
      b. Solomon Colors Inc.

E. Preblended Dry Mortar Mix: Packaged blend made from portland cement and hydrated lime, sand, mortar pigments, and admixtures and complying with ASTM C1714/C1714M.
   1. Preblended Dry Portland Cement Mortar Mix:

F. Aggregate for Mortar: ASTM C144.
   1. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C1384, and recommended by manufacturer for use in masonry mortar of composition indicated.

H. Water: Potable.

2.04 TIES AND ANCHORS

A. General: Ties and anchors extend at least 1-1/2 inches into veneer but with at least a 5/8-inch cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A153/A153M, Class B-2 coating.

C. Adjustable Masonry-Veneer Anchors:

1. General: Provide anchors that allow vertical adjustment but resist a 100 lbf load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch.
2. Fabricate wire ties from 0.187-inch- diameter, hot-dip galvanized steel wire unless otherwise indicated.
3. Masonry-Veneer Anchors; Seismic: Adjustable ladder eye-wire with hook and seismic clip interlock system.
   a. Basis-of-Design Product: Subject to compliance with requirements, provide Hohmann & Barnard, Inc: HB-270-2X S.I.S. Ladder or a comparable product by another manufacturer.

2.05 EMBEDDED FLASHING

A. Drainage Plane Flashing: Fabricate from stainless steel elastomeric membrane and drainage membrane to shapes indicated, including weep tabs, termination bar and drip edge. Provide flashing materials as follows:

1. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.016 inch thick.
2. Elastomeric Membrane: EPDM complying with ASTM D4637/D4637M, 40 mil.
3. Fabricate continuous flashings in sections 60 inches long, minimum.

B. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.06 ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neo-prene.

B. Weep/Vent Products: Use the following unless otherwise indicated:
   1. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from manufacturer's standard.

C. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
   1. Mortar Deflector: Strips, 1 inch and 16 inches high, with dovetail-shaped notches that prevent clogging with mortar droppings.

D. Proprietary Acidic Masonry Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

2.07 MORTAR MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
   1. Do not use calcium chloride in mortar or grout.
   2. Use portland cement-lime mortar unless otherwise indicated.
   3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Use Type S unless another type is indicated.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

3.02 TOLERANCES

A. Dimensions and Locations of Elements:
   1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.

2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:
1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 ft., or 1/2-inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 ft., 1/4 inch in 20 ft., or 1/2-inch maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2-inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 ft., 1/4 inch in 20 ft., or 1/2-inch maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2-inch maximum.

C. Joints:
1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.

3.03 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

C. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

3.04 MORTAR BEDDING AND JOINTING

A. Lay masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.05 ANCHORED MASONRY VENEERS

A. Anchor masonry veneers to masonry backup with seismic masonry-veneer anchors to comply with the following requirements:
   1. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
   2. Space anchors as indicated, but not more than 16 inches o.c. vertically and 16 inches o.c. horizontally, with not less than one anchor for each 2.67 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 24 inches, around perimeter.

B. Provide not less than 1 inch of airspace between back of masonry veneer and face of insulation.

3.06 FLASHING AND WEEP HOLES

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

B. Install flashing as follows unless otherwise indicated:
   1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape.
   2. Extend flashing through veneer, across airspace behind veneer, and up face of CMU at least 8 inches.
   3. At lintels and shelf angles, extend flashing 6 inches minimum, to edge of next full unit at each end. At heads and sills, extend flashing 6 inches minimum, to edge of next full unit and turn ends up not less than 2 inches to form end dams.
   4. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal drip edge.

C. Install weep holes in veneers in head joints of first course of masonry immediately above embedded flashing.
   1. Use specified weep/cavity vent products to form weep holes.
   2. Space weep holes 24 inches o.c. unless otherwise indicated.

D. Place cavity drainage material in airspace behind veneers to comply with configuration requirements for cavity drainage material in "Accessories" Article.

3.07 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements will be at Contractor's expense.

B. Inspections: Special inspections in accordance with Level 2 in TMS 402.
   1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.

C. Testing Prior to Construction: One set of tests.

D. Concrete Masonry Unit Test: For each type of unit provided, in accordance with ASTM C140/C140M for compressive strength.

E. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, in accordance with ASTM C780.

3.08 CLEANING

A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
   1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
   2. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
   3. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
   4. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.

3.09 MASONRY WASTE DISPOSAL

A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
   1. Do not dispose of masonry waste as fill within 18 inches of finished grade.

B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION

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SECTION 05 05 14

HOT-DIP GALVANIZING

PART 1 GENERAL

1.01 DESCRIPTION

A. Section includes: Hot-dip galvanizing of steel materials.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 09 90 00 Painting and Coating

1.03 REFERENCES:

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM A123	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A143	Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
ASTM A153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A384	Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
ASTM A385	Providing High-Quality Zinc Coatings (Hot-Dip)
ASTM A780	Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM B6	Zinc
ASTM D6386	Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
ASTM E536	Test Methods for Chemical Analysis of Zinc and Zinc Alloys
DOD-P-21035A	Paint, High Zinc Dust Content, Galvanizing Repair

1.04 SUBMITTALS

A. Action Submittals
   1. Procedure: Section 01 33 00:
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
4. Coating applicator's Certificate of Compliance that the hot-dip galvanized coating meets or exceeds the specified requirements of ASTM A123 or A153, as applicable.
5. Evidence that the galvanized coating applicator is a member of the American Galvanizing Association.

1.05 QUALITY ASSURANCE

A. Hot-dip galvanized coating applicator shall be a member of the American Galvanizing Association.

PART 2 PRODUCTS

2.01 MATERIALS

A. Zinc used for galvanizing shall conform to ASTM B6, and shall be at least equal to the grade designated as Prime Western.

B. Maximum amount of aluminum added to a galvanizing bath shall not exceed 0.01 percent.

C. Hot-Dip Galvanized Coating: Conform to ASTM A123 and A153, as applicable.

D. Repair: Zinc dust-zinc oxide coating conforming to DOD-P-21035A and containing 95 percent zinc in the dry film. Acceptable product is ZRC Cold Galvanizing Compound by ZRC Worldwide, or approved equal.

2.02 FABRICATION REQUIREMENTS

A. Fabrication practices for products to be galvanized: In accordance with applicable portions of ASTM A143, A384 and A385. Avoid fabrication techniques that could cause steel distortion or embrittlement.

B. Coordinate with steel detailer to provide vent and drain holes of sufficient size and quantity to achieve specified galvanized coating.

PART 3 EXECUTION

3.01 PREPARATION

A. Casting surfaces to be galvanized shall be sand blasted or ground smooth. When a smooth cast is required, castings shall be tumbled and all high spots ground flush. Castings shall be normalized to prevent cracking. Malleable iron shall be safeguarded against embrittlement by pre-annealing.

B. Steel work shall be precleaned utilizing a caustic bath, acid pickle and flux or shall be blast cleaned and fluxed to obtain an acceptable surface for quality hot dip galvanizing.

3.02 APPLICATION

A. Steel Members, Fabrications, and Assemblies: Hot-dip galvanize after fabrication in accordance with ASTM A123.

B. Steel Bolts, Screws, Nuts, Washers and Hardware Components: Hot-dip galvanize in accordance with ASTM A153.

3.03 COATING REQUIREMENTS

A. Hot-dip Coating Thickness: Conform to ASTM A123 or ASTM A153, as applicable.

3.04 TESTING

A. Chemical analysis for impurities in the bath shall be made in conformity with ASTM E536.

B. Test Requirements and Methods: In accordance with ASTM A123 or ASTMA153, as applicable.

3.05 GALVANIZED SURFACES TO BE PAINTED

A. Where galvanized surfaces are specified to be painted in Section 09 90 00 or elsewhere in the Project Manual, conform to ASTM D6386.

3.06 REPAIR OF DEFECTIVE GALVANIZED COATING

A. Where zinc coating has been damaged after installation, clean substrate surface and repair with zinc dust-zinc oxide coating in accordance with ASTM A780. Apply zinc dust-zinc oxide coating in accordance with manufacturer's recommendation. Apply multiple coats to achieve a minimum film thickness of 8 mils.

B. Remove items not physically damaged, but which have insufficient or deteriorating zinc coatings, and items damaged in shipment or prior to installation, from the project site for repair by the hot-dip zinc coating method.

END OF SECTION

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SECTION 05 05 20

ANCHOR BOLTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Bolts and all-thread rods used to attach structural elements and equipment to concrete and concrete masonry. Included are cast-in-place and post-installed anchors (adhesive systems and wedge type expansion anchors), nuts and washers.

B. Cast-in-place and post-installed anchors shall be Type 316 stainless steel unless noted otherwise.

1.01 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 73 24 Design Requirements for Nonstructural Components and Nonbuilding Structures
   2. Section 03 30 00 Cast-In-Place Concrete
   3. Section 03 60 00 Grouting
   4. Section 43 05 13 Rigid Equipment Mounts

1.02 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ACI 318	Building Code Requirements for Structural Concrete
ASTM A193	Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A320	Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
ASTM A563	Carbon and Alloy Steel Nuts
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
ASTM F844	Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F1554	Anchor Bolts, Steel, 36, 55, 105-ksi Yield Strength
IBC	International Building Code with local amendments

1.03 SUBMITTALS

A. Action Submittals
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. Anchor bolt placement plans.
   5. Anchor bolt, nut, and washer material information, including material certifications.
   6. Record copy of design calculations and details showing the required diameter, length, embedment, edge distance, confinement, anchor reinforcement, anchor bolt sleeves, connection redesign, and other conditions, stamped and signed by a Professional Engineer currently registered in the state of Arizona. Calculations shall comply with the provisions of ACI 318-14, Chapter 17. Base anchor capacity determination on cracked concrete condition and compressive strength of new concrete per Section 03 30 00. Assume compressive strength of existing concrete is 3,000 psi unless otherwise noted.
   7. Product Data:
      a. ICC Evaluation Service Reports for post-installed adhesive type anchors and expansion (wedge type) anchors when allowed. Products shall be ICC approved for use in cracked concrete in high seismic areas (Seismic Design Category D, E and F).
      b. Product data indicating load capacity charts/calculations.
      c. Chemical resistance.
      d. Temperature limitations.
      e. Manufacturers written installation instructions.
   8. Installer certification for horizontal or upwardly inclined adhesive anchors in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program.

1.04 QUALITY ASSURANCE

A. Quality Assurance By Owner
   1. Special inspection of anchor bolts shall be performed by the Special Inspector under contract with the Owner and in accordance with IBC Chapter 17.
   2. Adhesive anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads shall be continuously inspected during installation by a Special Inspector.

3. The Special Inspector shall furnish a report to the Engineer, Owner's Representative, and Building Official that the work covered by the report has been performed and that the materials used and the installation procedures used conform with the approved Project Manual and the Manufacturer's Printed Installation Instructions (MPII).

B. Certifications

1. Installer certification shall be in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program for installers of horizontal or upwardly inclined adhesive anchors.

PART 2 PRODUCTS

2.01 GENERAL

A. Anchor bolt holes in equipment support frames shall not exceed the bolt diameters by more than 1/4 inch. Minimum anchor bolt diameter shall be 1/2 inch. Anchor bolts for equipment mounting systems shall be provided as specified in Section 43 05 13.

B. Tapered washers shall be provided where mating surface is not square with the nut.

C. Anchor bolts shall be cast-in-place anchors unless post-installed anchors are specified or shown on the Drawings. Substitution of post-installed anchors will not be permitted unless specifically requested by the Contractor and approved by the Engineer.

2.02 PERFORMANCE/DESIGN CRITERIA

A. Anchor bolts for equipment shall be designed by the equipment manufacturer to include equipment operational loads combined with seismic and wind forces when applicable. Design criteria provided in Section 01 73 24.

B. Design anchor bolts for support and bracing of non-structural components and non-building structures for loading specified in Section 01 73 24.

2.03 MATERIALS

A. Anchor bolt materials shall be as specified in the following table:

Material	Specification
Stainless Steel Anchor Bolts	ASTM A193 or A320, Type 316
Stainless Steel Threaded Rods	ASTM F593, Type 316
Stainless Steel Nuts	ASTM A194 Heavy Hex Nuts, Type 316 ASTM F594 Heavy Hex Nuts at Adhesive Anchors, Type 316
Stainless Steel Washers	Type 316 to match bolt material
Carbon Steel Anchor Bolts	ASTM F1554, Grade 36, Hot Dip Galvanized
High-Strength Carbon Steel Anchor Bolts	ASTM F1554, Grade 55, Weldable per Supplementary Requirement S1, Hot Dip Galvanized
Carbon Steel Nuts and Washers	ASTM A563 and F844, Heavy Hex, Hot-Dip Galvanized
Concrete Adhesive Anchors	Hilti "HIT-RE 500v3", Simpson Strong-Tie "SET-XP", or approved equal, with Type 316 Stainless Steel threaded rods

Material	Specification
Concrete Masonry Adhesive Anchors	Hilti "HIT-HY 270", Simpson Strong-Tie “SET-XP”, or approved equal, with Type 316 Stainless Steel threaded rods
Concrete Masonry Expansion (wedge) Anchors*	Hilti "KWIK BOLT 3", or approved equal, Type 316 Stainless Steel
Concrete Expansion (wedge) Anchors *	Hilti “KWIK BOLT TZ2”, or approved equal, Type 316 Stainless Steel

**Post installed anchors shall always be an adhesive type anchor system except where noted otherwise or when Contractor makes a request for a specific application and Engineer approves.*

2.04 STAINLESS STEEL FASTENER LUBRICANT (ANTI-SEIZING)

A. Anti-seizing Lubricant for Stainless Steel Threaded Connections:
   1. Suitable for potable water supply.
   2. Formulated to resist washout.
   3. Acceptable manufacturers are Bostik, Saf-T-Eze, or equal.

2.05 ANCHOR BOLT SLEEVES

A. Provide anchor bolt sleeves as shown on design drawings and as required by equipment manufacturer’s design.
   1. Provide high density polyethylene plastic sleeves of single unit construction with deformed sidewalls such that the concrete and grout lock in place.
   2. The top of the sleeve shall be self-threading to provide adjustment of the threaded anchor bolt projection.
   3. Acceptable manufacturers are Contec, Wilson, or equal.

PART 3 EXECUTION

3.01 GENERAL

A. Anchor bolts shall be cast-in-place anchors unless post-installed anchors are specified or shown on the Drawings.

B. Grouting of anchor bolts using plastic sleeves with non-shrink or epoxy grout, where specified, shall be in accordance with Section 03 60 00.

C. The threaded end of anchor bolts and all-thread rods shall be long enough to project through the entire depth of the nut and if too long, shall be cut off at ½-inch beyond top of nut and ground smooth.

3.02 CAST-IN-PLACE ANCHOR BOLTS

A. Anchor bolts to be embedded in concrete shall be placed accurately and held in correct position using templates while the concrete is placed.

B. After anchor bolts have been embedded, their threads shall be protected by grease and the nuts run on.

3.03 ADHESIVE ANCHOR BOLTS

A. Note that adhesive anchors shall not be substituted for cast-in-place anchor bolts unless the adhesive anchors have been specified or shown on the Drawings, or approval has been obtained from the Engineer that substitution of adhesive anchors is acceptable for the specific use and location. Use of adhesive anchors shall be subject to the following conditions:
   1. Limit to locations where intermittent or continuous exposure to the following is extremely unlikely:
      a. Acid concentrations higher than 10 percent
      b. Chlorine gas
      c. Machine or diesel oils
   2. Limit to applications where exposure to the following is extremely unlikely:
      a. Fire
      b. Concrete or rod temperature above 120 degrees F
   3. Overhead applications (such as pipe supports) shall not be allowed unless approved by the Engineer and installation is by an Installer specially certified for overhead applications.
   4. Approval from Engineer for specific application and from supplier of equipment to be anchored, if applicable.
   5. Anchor diameter and material shall be per Contract Documents or equipment manufacturer's specifications. Anchor shall be threaded or deformed the full length of embedment and shall be free of rust, scale, grease, and oils.
   6. Embedment depth shall be as specified or as required by the equipment manufacturer.
   7. Follow the anchor system manufacturer's installation instructions.
   8. Holes shall have rough surfaces created by using a hammer drill with carbide bit. Core drilled holes are not allowed.
   9. Holes shall be blown clean with oil-free compressed air and be free of dust or standing water prior to installation. Follow additional requirements of the adhesive manufacturer.
   10. Concrete and air temperature shall be compatible with curing requirements of adhesives per adhesive manufacturer's instructions. Anchors shall not be placed in concrete when the temperature is below 25 degrees F.
   11. Anchors shall be left undisturbed and unloaded for full adhesive curing period, which is based on temperature of the concrete.

3.04 EXPANSION ANCHORS

A. Expansion (wedge type) anchors shall not be substituted for cast-in-place anchor bolts or adhesive anchors unless approved by the Engineer for a specific application. Use of expansion anchors shall be subject to conditions 4 through 9 as specified above for adhesive anchors. Expansion anchors shall not be used in a submerged condition or in mounting of equipment subject to vibration or cyclic motion.

3.05 REINFORCING STEEL CONFLICTS WITH POST-INSTALLED ANCHOR INSTALLATION

A. When reinforcing steel is encountered in the drill path, slant drill to clear obstruction and provide beveled washer to match angle of anchor. Drill shall not be slanted more than 10 degrees.

B. Where slanting the drill does not resolve the conflict, notify the Owner's Representative and resolve the conflict to the satisfaction of the Owner's Representative in consultation with the Engineer.

C. Abandoned post-installed anchor holes shall be cleaned and filled with non-shrink grout and struck off flush with adjacent surface.

D. The costs of determining and executing the resolution shall be borne by the Contractor. The determination and execution of the resolution shall not result in additional cost to the Owner.

E. Reinforcing steel in masonry shall not be damaged.

F. In order to avoid or resolve a conflict, locate embedded reinforcing steel using non-destructive methods and/or redesign the attachment.
   1. Redesign shall be done by the Contractor's Professional Engineer currently registered in the state of Arizona.
   2. Calculations and details for redesign shall be submitted.

END OF SECTION

SECTION 05 10 00

STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Structural metals consisting of standard shapes, hollow sections, fasteners, rods and plates that are used in structural supports and connections.

1.02 RELATED SECTIONSREFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
Aluminum Design Manual	The Aluminum Association, Aluminum Design Manual with Specifications and Guidelines for Aluminum Structures
AISC 201	AISC Certification Program for Structural Steel Fabricators
AISC 303	Code of Standard Practice for Steel Buildings and Bridges
AISC 360	Specification for Structural Steel Buildings
AISC 810	Erection Bracing of Low-Rise Structural Steel Frames
ASTM A6	General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A36	Carbon Structural Steel
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A193	Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A320	Alloy-Steel and Stainless Steel Bolting for Low Temperature Service
ASTM A325	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A384	Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
ASTM A500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A563	Carbon and Alloy Steel Nuts
ASTM A992	Structural Steel Shapes
ASTM B209	Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B241	Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
ASTM B308	Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM F436	Hardened Steel Washers
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
AWS-B3.0	Welding Procedures and Performance Qualifications
AWS-D1.1	Structural Welding Code--Steel

Reference	Title
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.6	Structural Welding Code - Stainless Steel
ASW D1.8	Structural Welding Code – Seismic Supplement
IBC	International Building Code
AISC Steel Construction Manual	American Institute of Steel Construction, Manual of Steel Construction

1.03 SUBMITTALS

A. Action Submittals:

1. Procedures: Section 01 33 00.
2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
4. Shop drawings for approval prior to fabrication. Shop drawings shall not be reproductions of the Drawings. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, coatings, connection details, blocks, copes, and cuts. Substitutions of details shown on the Drawings shall be clearly highlighted on the fabrication drawings. Explain the reasons for any deviations from the Drawings.
5. Certification that steel fabricator is approved to perform steel fabrication without special inspection.
6. AISC quality certification: Evidence that steel fabricator has AISC 201 Certification as a “Standard Steel Building Structures” fabricator. Certificate to show name and address of certified firm, effective date, and category of certification.
7. Welding procedures, qualifications, and inspection report.
8. Certified mill test reports for structural steel and high-strength bolts and nuts.
9. In accordance with IBC Chapter 17, Fabricator at the completion of fabrication to submit Certification of Compliance stating that the fabrication was performed in accordance with the design documents.
10. Certified copies of all surveys conducted by a registered professional engineer or surveyor showing elevations and locations of base plates and anchor bolts to receive structural steel or aluminum, and final elevations and locations for major members. Indicate discrepancies between actual installation and contract documents.

1.04 QUALITY ASSURANCE

A. Quality Control by Owner:
   1. Special Inspection of structural metals work shall be performed by the Special Inspector under contract with the Owner and in conformance with the IBC Chapter 17. Special Inspector(s) and laboratory shall be acceptable to the Owner in their sole discretion. Special Inspection of structural metals is in addition to, but not replacing, other inspections and quality control requirements herein. Where sampling and testing required herein conforms to Special Inspection standards, such sampling and testing need not be duplicated.
   2. All structural steel work shall receive Special Inspection in accordance with IBC, Chapter 17. Structural steel includes all steel elements that resist code-defined loads and whose failure would affect life safety. Items to be inspected include, but are not limited to, mechanical/electrical supports, beams, stringers, columns, access walkways and stairways.

B. Fabricator Qualifications:
   1. A qualified fabricator must participate in the AISC 201 Certification program and be designated an AISC Certified Plant, Category STD (Standard for Steel Building Structures).

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel:
   1. Materials for structural metals shall be as specified in Table A.

Table A - Steel Materials

Material	Specification
Standard steel S-shapes, channels, angles and plates	ASTM A36
Standard rolled steel wide-flange sections and WTs	ASTM A992
Pipe sections for posts	ASTM A53, Type E or S, Grade B
Round Hollow Structural Sections (HSS)	ASTM A500, Grade C (Fy = 46 ksi)
Square and Rectangular Hollow Structural Sections (HSS)	ASTM A500, Grade C (Fy = 50 ksi)
Stainless steel bolts (used at stainless steel and aluminum framing unless noted otherwise)	ASTM F593, Type 316
Stainless steel nuts and washers (used at stainless steel and aluminum framing unless noted otherwise)	ASTM F594, Type 316
Steel bolts (used at galvanized and painted steel framing)	Galvanized ASTM A325 (Type 1), bearing type bolts fully tensioned
Carbon steel nuts and washers	Galvanized ASTM A563 nuts and galvanized ASTM F436 washers

B. Aluminum:

Table B - Aluminum Materials

Material	Specification
Aluminum structural shapes	Alloy 6061-T6 per ASTM B308
Bolts	Use stainless steel bolts for aluminum framing (see Table A above)
Aluminum guardrail and handrail pipe	Alloy 6061-T6 or 6063-T6 per ASTM B241
Aluminum plates	Alloy 6061-T6 per ASTM B209

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and accept conditions before beginning work.

3.02 FABRICATION

A. Fabrication of steel shall be in accordance with the applicable provisions of the AISC Steel Construction Manual, Fifteenth Edition. Fabrication of aluminum shall be in accordance with Aluminum Design Manual – Latest Edition. Fabrication and assembly shall be done in the shop to the greatest extent possible. The fabricating plant shall be certified under AISC 201 for Category STD (Standard for Steel Building Structures).

B. Compression joints depending on contact bearing shall have a surface roughness not in excess of 500 micro-inch and ends shall be square within the tolerances for milled ends specified in ASTM A6.

C. Shop splices of members will be permitted only where indicated on the Drawings. Splices not indicated require the approval of the Owner's Representative.

D. Verify measurements at the job site prior to fabrication. Fabricate to match job site measurements.

E. Provide holes as necessary or as indicated for securing other work to structural steel framing, and for passage of other work through steel framing members.

3.03 INSTALLATION

A. General:
   1. Erection of structural steel shall be in accordance with the applicable provisions of AISC Steel Construction Manual. Erection plan shall conform to AISC 303. For low-rise structural steel buildings, 60 feet tall or less and a maximum of 2 stories, the structure shall be erected in accordance with AISC 810.
   2. Coordinate installation of anchor bolts and other connectors required for securing structural steel to in place work.
   3. Employ a registered professional engineer or surveyor for accurate erection of the structural steel. Check elevations of concrete and locations of anchor bolts before erection proceeds and report discrepancies to the Owner's Representative.
   4. Placement tolerances shall be in accordance with AISC 303.

5. After final positioning of steel members, provide full bearing under base plates and bearing plates using non-shrink grout. Place non-shrink grout in accordance with the manufacturer's instructions.
6. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings or isolators. Protect aluminum in contact with concrete or grout with a heavy coat of bituminous paint.
7. Metalwork to be embedded in concrete shall be placed accurately and held in correct position while the concrete is placed. The surfaces of metalwork in contact with or embedded in concrete shall be thoroughly cleaned.
8. Structural steel completely encased in concrete shall not be galvanized or painted and shall have a clean surface for bonding to concrete.
9. Metalwork which is bent, broken or otherwise damaged shall be repaired or replaced.

B. Welding:
1. Welding shall be done by welders, welding operators, and tackers who have been qualified by tests as prescribed by AWS to perform the type of work required. The quality of welding shall conform to AWS Codes.
2. Develop and submit the Welding Procedure Specifications (WPS) for all welding, including welding done using prequalified procedures.
3. Provide continuous seal welds for plates or structural shapes that are exposed to or submerged in water or wastewater.

C. Bolted Connections:
1. Bolted connections, unless noted otherwise, shall conform to AISC 360 and shall be bearing type connections with bolts fully tensioned unless connecting HSS shapes. Punch, subpunch and ream, or drill bolt holes perpendicular to the surface of the member. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Bolts, nuts, and washers shall be clean of dirt and rust and lubricated immediately prior to installation. No drifting of bolts or enlargement of holes will be allowed to correct misalignment. Holes shall not be cut or enlarged by burning. Mismatched holes shall be corrected with new material.

3.04 CORROSION PROTECTION

A. Unless otherwise specified, carbon steel shall be galvanized. If coatings are indicated on the Drawings or elsewhere in the Specifications, coat in accordance with Section 09 90 00. Coating surface preparation shall be as specified in Section 09 90 00 and shall include the following operations:
1. Grind the exterior and interior edges of all flame-cut plates or members to a smooth surface.
2. Grind all sharp edges off of the sheared plates and punched holes.
3. Grind uneven or rough welds with high beads to a smooth finish.

3.05 CLEANING

A. After installation, damaged surfaces of shop primed metals shall be cleaned and touched up with the same material used for the shop coat. Damaged surfaces of galvanized metals shall be repaired as specified in Section 05 05 14.

END OF SECTION

SECTION 05 21 19

OPEN WEB STEEL JOIST FRAMING

PART 1 GENERAL

1.01 DESCRIPTION

A. Work Included:
   1. Provide all open web steel joists complete in place as shown on the drawings, specified herein, and needed for a complete and proper installation.

1.02 QUALITY ASSURANCE

A. Standards:
   1. Comply with standard specifications for Open Web Joists, by the Steel Joist Institute, latest edition, and any other standards specified in this section.

B. Qualifications of Welders:
   1. Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedures."

C. References:
   1. This section references the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section will prevail.

Reference	Title
ASTM A36	Structural steel
ASTM A242	Structural steel, high-strength low-alloy
ASTM A441	Structural manganese vanadium steel
ASTM A470	Hot-rolled carbon steel
ASTM A572, Grade 50	High-strength low-alloy Columbium-vanadium steel
ASTM A588	High-strength low-alloy structural steel with 50 ksi minimum yield point
ASTM A606	Steel sheet and strip, hot-rolled and cold-rolled, high-strength, low-alloy, with improved atmospheric corrosion resistance
ASTM A607	Steel sheet and strip, hot-rolled and cold-rolled, high-strength, low-alloy columbium and/or vanadium
ASTM A611, Grade D	Steel, cold-rolled sheet, carbon, structural
Steel Joist Institute	Standard Specifications and Load and Weight Tables for Steel Joists and Joist Girders
AWS D1.1	Structural Welding Code - Steel

1.03 SUBMITTALS

A. General:
   1. Comply with pertinent provisions of Section 01 33 00.

B. Manufacturer's Data:
   1. Within 35 calendar days after award of the contract, submit:

a. Manufacturer's specifications and installation instructions for each type of open web joist, bridging, and accessories. Include manufacturers' certifications for Open Web Joists, by the Steel Joist Institute, latest edition.
b. Detailed elevation and section of each joist.
c. Joists for which standard load tables are not applicable shall be prepared, stamps, and signed by a Professional Engineer registered in the State of Arizona.
d. Calculations, sealed by an Arizona Registered Engineer verifying the design of the joists.
e. Submit a certification letter stating compliance with SJI Standard Specifications.

1.04 PRODUCT HANDLING

A. Protection:
1. Use all means necessary to protect materials of this section before, during, and after installation, and to protect work and materials of all other trades.

B. Replacement:
1. In the event of damage, immediately inform the Construction Manager. Make no repairs without the approval of the Construction Manager and the joist supplier. Replacements, if necessary, shall be timely and at no additional cost to the Owner.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel:
1. Steel shall conform to one of the following specifications:
a. ASTM A36
b. ASTM A242
c. ASTM A441
d. ASTM A570
e. ASTM A572, Grade 50
f. ASTM A588
g. ASTM A606
h. ASTM A607, Grade 50
i. ASTM A611, Grade D

B. Finish:
1. Shop applied coat to red oxide metal primer, provide field touch-up.

2.02 FABRICATION

A. General:
1. Joists shall be designed and manufactured in accordance with the above referenced standard specifications.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine the areas and conditions under which open web steel joists are to be installed and correct conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General:
   1. Install open web steel joists, bridging, and any required accessories in accordance with manufacturer's recommendations and approved shop drawings, and as specified herein.

B. Touch-Up:
   1. After completion of installation, wire brush, clean, and touch-up joists and accessories, where welded, or where primer is missing, with primer repair paint as provided by the manufacturer, applied in accordance with manufacturer's instructions.

END OF SECTION

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SECTION 05 31 23

STEEL ROOF DECKING

PART 1 GENERAL

1.01 DESCRIPTION

A. General:
   1. This section specifies fabrication and erection of steel roof deck.

B. Related Sections:
   1. The work of the following Sections is related to the work of this Section. Other Sections, not referenced below, may also be related to the proper performance of this work.
      a. Section 05 10 00 – Structural Metal Framing.
      b. Section 05 05 14 – Hot-Dip Galvanizing.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
AISI SG-673	Design of Cold-Formed Steel Structural Members
ASTM A36	Carbon Structural Steel
ASTM A611	Steel, Sheet, Carbon, Cold Rolled, Structural Quality
ASTM A653	Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron, Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM 780	Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings
ASTM A924	Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM D1056	Standard Specification for Flexible Cellular Materials Sponge or Expanded Rubber.
AWS D1.3	Structural Welding Code Sheet Steel
Steel Deck Institute (SDI)	Design Manual for Composite Decks, Form Decks, Roof Decks, and Cellular Metal Floor Deck with Electrical Distribution

1.03 SUBMITTALS

A. Procedures: Section 01 33 00.

B. Complete shop drawings showing framing and deck layout indicating length, type, cross section, thickness, markings of metal deck units, and size and locations of all openings. Shop drawings shall not be a reproduction of the Contract Drawings.

C. Details and gages of all accessories and miscellaneous items showing sump pans, cant strips, ridge and valley plates, closure strips and insulation supports.

D. Manufacturer's load table including design thickness in inches, section properties, allowable gravity load, allowable diaphragm shear loads.

E. Erection marks. Mark each bundle to correspond to the shop drawings.

F. Certification from SDI that manufacturer is a member of SDI and that the steel roof deck is designed in accordance with SDI standards.

G. Certification for installers of deck fastening systems.

1.04 QUALITY ASSURANCE

A. Steel roof deck shall conform to the requirements of the SDI standard for Steel Roof Deck.

B. Deck manufacturer shall be a member of the Steel Deck Institute.

C. Deck installer shall have minimum three years experience on comparable steel deck projects. Installers shall be trained and certified by manufacturer to install fastening systems.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store materials off the ground with one end elevated to provide drainage. Protect from the elements with a waterproof covering, ventilated to avoid condensation. Prevent rust, deterioration and accumulation of foreign materials.

PART 2 PRODUCTS

2.01 MATERIALS

A. Sheet Steel:
   1. ASTM A653, SS, Grade 50 with Designation G60 galvanized coating.

B. Structural Steel:
   1. ASTM A36.

C. Galvanizing Repair Paint:
   1. Paint shall be 95 percent zinc dust, organic vehicle primer compatible with galvanized surfaces per Section 05 05 14.

2.02 FABRICATION

A. General:
   1. Form deck units in lengths to span three or more support spacings, with minimum two-inch laps and side laps. Configuration shall be appropriate for side lap connection.
   2. Deck profile and gage shall be as shown on the drawings. Acceptable manufacturer is Verco, Nucor Vulcraft or approved equal.

B. Closure Plates:
   1. Fabricate closure plates of galvanized sheet steel of same quality as deck units. Provide tight-fitting closure with deck units.

C. Fabrication Tolerances:
   1. Maximum variation in unit alignment shall be 1/4 inch in 40 feet.

PART 3 EXECUTION

3.01 INSPECTION

A. Check supporting members for correct layout and alignment. Verify that surfaces to receive steel deck are free of debris. Do not proceed with installation until defects are corrected.

3.02 INSTALLATION

A. Install steel roof deck and accessories in accordance with the manufacturer's instructions and in accordance with final approved shop drawings and as specified herein.

B. Fasten steel roof deck to all interior and exterior transverse supports and at side laps and longitudinal supports. Deck fasteners and fastener spacing shall be as shown on the Drawings. End lap of steel roof deck shall be at least 2 inches and shall occur over transverse supporting members.

C. Coordinate size, location, and details of penetrations with the Drawings, other trades, and details of approved equipment. Pipe and conduit openings in the steel roof deck shall be reinforced according to the manufacturer's recommendation.
   1. Cutting and Fittings:
      a. Cut and fit steel roof deck units and accessories around projections through steel roof deck.
      b. Make cuts neat, square, and trim.
      c. Cut openings in steel roof deck true to dimensions using metal saws or drills.
      d. Do not use cutting torches.
      e. Openings greater than 6-in and less than 12-in in greatest dimension shall be reinforced with a 24-in by 24-in flat plate, minimum 20-gauge thickness, centered on the opening.

D. Suspended ceilings, light fixtures, ducts, piping, conduits, or other utilities shall not be attached to steel roof deck.

3.03 FIELD PAINTING

A. Touch up galvanized surfaces with galvanizing repair paint applied in accordance with manufacturer’s instructions and Section 05 05 14.

3.04 INSPECTION

A. The Engineer reserves the right to inspect steel roof deck in the field for compliance with the requirements specified herein and the approved shop drawings. The Engineer may reject or require repair or re-fabrication of steel roof deck or accessories not meeting these requirements.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Custom fabricated metal items and certain manufactured units not otherwise indicated to be provided under work of other specification sections.
   2. Seat angle frames
   3. Fall arrest anchors
   4. Iron castings
   5. Ladders, ladder cages, and safety posts
   6. Ladder Rail Fall Protection System
   7. Ship's ladders
   8. Cover plates and frames
   9. Pipe sleeves
   10. Bollards
   11. Stairs
   12. Safety nosings at concrete stairs
   13. Miscellaneous metal fabrications not covered elsewhere

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 73 24 Design Requirements for Nonstructural Components and Nonbuilding Structures
   2. Section 05 05 14 Hot-Dip Galvanizing.
   3. Section 05 05 20 Anchor Bolts
   4. Section 05 10 00 Structural Metal Framing
   5. Section 05 52 10 Aluminum Railings
   6. Section 05 53 10 Metal Gratings and Stair Treads
   7. Section 09 90 00 Painting and Coating

1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
Aluminum Design Manual	The Aluminum Association, Aluminum Design Manual with Specifications and Guidelines for Aluminum Structures

Reference	Title
AISC 303	Code of Standard Practice for Steel Buildings and Bridges
AISC 360	Specification for Structural Steel Buildings
AISC Steel Construction Manual	American Institute of Steel Construction, Manual of Steel Construction
ANSI A14.3	Standard for Ladders - Fixed - Safety Requirements
ASTM A36	Carbon Structural Steel
ASTM A48	Gray-Iron Castings
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A123	Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A193	Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A240	Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A276	Stainless Steel Bars and Shapes
ASTM A283	Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A307	Carbon Steel Bolts, Studs, and Threaded Rod 60000 psi Tensile Strength
ASTM A312	Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A320	Alloy-Steel Bolting Materials for Low Temperature Service
ASTM A325	Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength
ASTM A380	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A384	Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
ASTM A489	Carbon Steel Lifting Eyes
ASTM A500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A554	Welded Stainless Steel Mechanical Tubing
ASTM A563	Carbon and Alloy Steel Nuts
ASTM A572	High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A653	Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by the Hot Dip Process
ASTM A780	Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings
ASTM A786	Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
ASTM A793	Rolled Floor Plate, Stainless Steel
ASTM A924	Steel Sheet, Metallic-Coated by Hot-Dip Process
ASTM A992	Structural Steel Shapes
ASTM A1011	Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B209	Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B210	Aluminum and Aluminum-Alloy Drawn Seamless Tubes

Reference	Title
ASTM B211	Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire
ASTM B221	Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B241	Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
ASTM B308	Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM B429	Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM B632	Aluminum-Alloy Rolled Tread Plate
ASTM D1056	Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM F436	Hardened Steel Washers
ASTM F468	Nonferrous Bolts, Hex Cap Screws, SocketHead Cap Screws and Studs for General Use
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
AWS D1.1	Structural Welding Code - Steel
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.6	Structural Welding Code - Stainless Steel
OSHA 29 CFR 1910.27	Fixed Ladders
OSHA 29 CFR 1926.502	Fall Protection Systems Criteria and Practices
SSPC SP5	White Metal Blast Cleaning
IBC	International Building Code

1.04 DEFINITIONS

A. Galvanize: Hot-dip galvanize per ASTM A123 or ASTM A153, per Section 05 05 14.

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration
   4. Manufacturer's product data.
   5. Detailed Shop Drawings:
      a. Fabrication drawings showing layouts, connections to structural system, and anchoring details.

b. Erection and installation drawings indicating thickness, type, grade, class of metal, coating system and dimensions.
c. Construction details, reinforcement, anchorage, and installation with relation to the building construction.

6. Welding procedures and welder certificates and qualifications.
7. Passivation method for stainless steel fabrications.
8. Fall Arrest Anchor Certificate:
   a. Certify fall arrest system is designed to meet OSHA 29 CFR 1926.502 specified performance requirements.
   b. Signed and sealed by a Professional Engineer licensed in the state in which the project is located.

1.06 QUALITY ASSURANCE

A. Qualifications
   1. Fabricator shall have a minimum of five years' experience in fabrication of metal specified.

B. Certificates
   1. Certified welding procedures and welding operators in accordance with AWS. Welding operator certificates shall be no more than one-year old and the welder shall have used the welding process to be performed within the last six months.

C. The use of salvaged, reprocessed or scrap materials will not be permitted.

D. Shop Assembly: Items in the shop shall be preassembled to the greatest extent possible, so as to minimize field splicing and assembly of units. Units shall be disassembled only to the extent necessary for shipping and handling limitations. Units shall be clearly marked for reassembly and coordinated installation.

1.07 DELIVERY, STORAGE AND HANDLING

A. Avoid damage during delivery and handling of fabrications.

B. Store off the ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials for miscellaneous metalwork are specified in the following table.

Material	Specification
Steel	
Sheets, plates and shapes (except W shapes)	ASTM A36
W shapes	ASTM A992
Pipe	ASTM A53, Grade B
Square/rectangular tubing	ASTM A500, Grade C

Material	Specification
Headed Anchor Studs	ASTM A108
Carbon steel bolts	ASTM A307, Grade A
High strength bolts	ASTM A325 (Type 1)
Nuts	ASTM A563
Washers	ASTM F436
Stainless Steel	
Sheet and Plates	ASTM A240, Type 316 or 316L
Shapes, bars, and similar items	ASTM A276, Type 316 or 316L
Pipe	ASTM A312, Type 316 or 316L
Headed Anchor Studs	ASTM A276, Type 316L
Bolts	ASTM F593, Type 316
Nuts	ASTM F594, Type 316
Aluminum	
Sheets and plates	ASTM B209, Type 6061-T6
Bars, flats and similar items	ASTM B211 or B221, Type 6061-T6
Shapes	ASTM B308, Type 6061-T6
Round tubing and pipe	ASTM B241, Type 6061-T6
Square and rectangular tubing	ASTM B221, Type 6063-T52
Pipe	ASTM B211 or B241, Type 6061-T6
Bolts, Stainless Steel	ASTM F593, Type 316
Nuts, Stainless Steel	ASTM F594, Type 316
Checker Plate	
Steel	ASTM A786
Stainless steel	ASTM A793, Type 304
Aluminum	ASTM B632, Type 6061-T6
Other steel items	
Iron castings	ASTM A48
Eyebolts	ASTM A489
Threaded rods	ASTM A36

2.02 FABRICATION

A. General

1. Conform to AISC or Aluminum Association standards as applicable. Where Code defined loads apply, also conform to IBC requirements.
2. Shop and field welding shall conform to the requirements of AISC, the Aluminum Design Manual, and applicable AWS procedures and specifications as required by the material being welded.
3. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt, tight, flush, and hairline. Remove burrs and weld splatter. Ease exposed edges to small uniform radius.
4. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Whenever needed, because of the thickness of the metal, holes shall be subpunched and reamed or shall be drilled.
5. Fabrication, including cutting, drilling, punching, threading and tapping required for fabrications or adjacent work, shall be performed prior to galvanizing.

B. Seat Angle Frames

1. Provide recessed seat angle frames for grating and floor plates. Miter corners to ensure accurate fit. Match depth of recess with grating or floor plate thickness. Anchor frames in concrete with headed studs. Steel angle support frames shall be stainless steel, ASTM A276, Type 316, unless indicated otherwise.

C. Fall Arrest Anchors

1. Fall arrest anchors shall meet requirements of OSHA 29 CFR 1926.502. Anchorages attached to personal fall arrest equipment shall be capable of supporting at least 5,000 pounds per employee attached, or shall be designed, installed, and used as part of a complete personal fall arrest system which maintains a safety factor of at least two. Type of anchor shall fit the application and substrate material.
2. Fall arrest anchors shall be manufactured by:
    a. Thaler Metal Industries
    b. DBI-SALA
    c. Approved Equal

D. Iron Castings

1. Castings shall be as specified on the Drawings. Castings weighing less than 100 pounds shall be galvanized after machining. Castings weighing greater than 100 pounds shall be galvanized where specified.

E. Ladders

1. Steel Ladders: Provide vertical ladders conforming to 29 CFR 1910.27. As a minimum, provide 2 1/2 inch by 3/8 inch steel flat bars for side rails and 3/4 inch diameter steel rods for rungs unless otherwise indicated on the Drawings. Rungs shall be a minimum clear length of 16 inches, uniformly spaced at a maximum of 12 inches and plug welded into side rails. Install ladders so that the distance from the centerline of rungs to the finished wall surface is not less than 7 inches nor more than 12 inches. Provide clip angle supports bolted to the side rail at the top. Provide intermediate clip angle lateral supports at a maximum of 10 feet on center.
2. Ladder Safety Post:
    a. Provide a telescoping ladder safety post at ladders below all floor and roof hatches, and other coverings.
    b. The ladder safety post shall be pre-assembled from the manufacturer.
    c. Performance characteristics:
        1) Post shall lock automatically when fully extended.
        2) Post shall have controlled upward and downward movement.
        3) Release lever shall disengage the post to allow it to be returned to its lowered position.
        4) Post shall have adjustable mounting brackets to fit ladder rung spacing up to 14” on center and clamp brackets to accommodate ladder rungs up to 1-3/4” in diameter.
        5) Post: Manufactured of high strength square tubing with a pull up loop provided at the upper end of the post to facilitate raising the post.
        6) Material of construction: Stainless steel Type 316

7) Balancing spring: Stainless steel spring balancing mechanism to provide smooth, easy, controlled operation when raising and lowering the safety post.

d. Acceptable products include:
   1) LadderUp Safety Post by Bilco
   2) Ladder Safety Post Model SP by Nystrom Inc.

3. Approved equal Ladder Rail Fall Protection System:
   a. System shall consist of a vertical rigid track carrier rail securely and permanently attached to ladder, over which travels a sleeve to harness belt can be attached.
   b. Rail:
      1) Notched at six-inch intervals and constructed of stainless steel Type 316.
      2) Provide ladder attachments/rail mounting brackets of same material as rail, and as required by Supplier.
      3) For all ladders, include provisions to secure safety sleeve to carrier rail at top of vertical ladder so that sleeve will not slide down rail when safety belt is unsnapped.
      4) Ladders Below Hatches: Rail for ladder shall extend from bottom of ladder to top of ladder. Provide telescopic safety post.
      5) Ladders Not Below Hatches: Rail for ladder shall extend from bottom of ladder to above horizontal landing or roof at top of ladder. Provide removable extension section at top of ladder. Arrange rail to allow climber to land on landing or roof without unsnapping climber's safety harness.
   c. Accessories: Provide with each ladder the following, all furnished by the fall prevention system Supplier:
      1) One safety sleeve compatible for use with the rail. Sleeve shall be cast bronze with five zinc plated steel roller bearings. Sleeve shall travel smoothly on straight or curved rail.
      2) One safety harness that attaches to sleeve. Harness shall be of woven high-strength nylon, with padded straps and forged steel buckles and rings. Harness shall distribute impact forces of a fall over climber's thighs, buttocks, chest, and shoulders.
      3) One shock adsorbing lanyard no longer than six-feet, complying with ANSI Z359.1. Lanyard shall be 5/8-inch diameter nylon rope with double locking hooks at each end.
   d. Acceptable ladder rail fall protection systems include:
      1) Miller Saf-T-Climb as manufactured by Honeywell
      2) Vertical Rigid Track Fall Arrest System as manufactured by Diversified Fall Protection
      3) Approved equal

F. Cover Plates and Frames

1. Fabricate aluminum cover plates weighing not more than 80 pounds per cover with a raised pattern nonslip top surface conforming to ASTM B632. Reinforce to sustain a live load of 100 pounds per square foot (foot traffic only) or as indicated on the Drawings. Frames shall be stainless steel angles and plates, with stainless steel headed anchors welded to frame for anchoring to concrete. Miter and weld corners and butt joint straight runs. Provide flush drop handles for removal. Remove sharp edges and burrs from cover plates and exposed edges of frames. Weld connections and grind top surface smooth. Provide 1/8 inch clearance at edges.

G. Pipe Sleeves

1. Unless otherwise indicated on the Drawings, fabricate pipe sleeves from schedule 40 steel pipe with 3/16 inch thick by 3 feet wide seep ring continuously seal welded to the outside of the pipe. Galvanize after fabrication in accordance with ASTM A123.

H. Bollards

1. Provide minimum 6 inch galvanized standard weight steel pipe or as indicated on the Drawings. Pipe to be in accordance with ASTM A53. Anchor posts in concrete and fill solidly with concrete of a minimum compressive strength of 2500 psi. Coat galvanized pipe above grade in accordance with Section 09 90 00. Top coat cover color shall be safety yellow.

I. Stairs – Aluminum

1. Provide aluminum stairs complete with stringers, grating treads, landings, columns, guardrails, handrails, and necessary bolts and other fastenings.
2. Fabricate stringers of structural aluminum channels. Provide closures for exposed ends of stringers. Construct landings of structural channel headers and miscellaneous framing members.
3. Grating Treads and Landings: Provide aluminum grating for treads and landings conforming to Section 05 53 10. Fabricate grating treads with abrasive nosing and with angle or plate carrier at each end for stringer connections. Secure treads to stringers with bolts. Fabricate grating landings with nosing that matches grating treads. Provide toe-plates at open-sided edges of landing.
4. Provide railings for stairs and platforms in accordance with Section 05 52 10.

J. Safety Nosings at Concrete Stairs

1. Safety stair treads shall be 4 inches wide and manufactured by:
   a. Safe T Metal Company Incorporated, Style AX;
   b. Wooster Products Incorporated, Alumogrit, Type 101;
   c. Approved Equal.

K. Other Miscellaneous Steel Metalwork

1. Other miscellaneous steel metalwork including embedded and non-embedded steel metalwork, hangers and inserts shall be as specified or shown on the Drawings, and shall be galvanized after fabrication unless otherwise noted.

2.03 FINISHES

A. Galvanizing
   1. Galvanize items specified to be zinc-coated, after fabrication where practicable. Galvanizing in accordance with ASTM A123, ASTM A153, ASTM A653 or ASTM A924, Z275 G90, as applicable. Galvanize anchor bolts, grating fasteners, washers, and parts or devices necessary for proper installation, unless indicated otherwise.
   2. Repair damaged Zinc-Coated surfaces with galvanizing repair method and paint conforming to ASTM A780 or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved by Owner's Representative.
   3. Safeguard against warpage and distortion during galvanizing of steel in accordance with ASTM A384. Straighten items after galvanizing so that they are straight, free of racking and distortion.

B. Shop Painting
   1. Prepare and coat surfaces in accordance with Section 09 90 00.
   2. Steel to be embedded in concrete shall be free of dirt and grease.

C. Aluminum Surfaces
   1. Surface condition aluminum before finishes are applied. Remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces.
   2. Aluminum finishes for unexposed sheet, plate and extrusions may have mill finish as fabricated.
   3. Provide other aluminum items with a standard mill finish.
   4. Provide a coating thickness not less than that specified for protection.
   5. Provide decorative type finishes for items used in interior occupied locations or architectural type finish for items used in exterior locations.
   6. Provide a polished satin finish on items to be anodized.

D. Stainless Steel Passivation
   1. Stainless steel to be cleaned, descaled, and passivated after fabrication in accordance with ASTM A380. Passivate to remove iron compounds from the surface of the stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify measurements at the site. Include field dimensions in shop drawings.

B. Examine and accept existing conditions before beginning work.

3.02 PREPARATION

A. Make provisions for erection loads with temporary bracing. Keep work in alignment.

B. Supply items required to be cast into concrete or embedded in masonry with setting templates.

3.03 INSTALLATION

A. Install items plumb, level and square, accurately fitted, and free from distortion or defects. Install rigid, substantial, and neat in appearance.

B. Allow for erection loads and provide temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

C. Fieldwork shall not be permitted on galvanized items. Drilling of bolts or enlargement of holes to correct misalignment will not be allowed.

D. Protect encased or embedded dissimilar metals (both metals must be encased or embedded) from galvanic corrosion by means of pressure tapes, coatings or isolators.

E. Place metalwork to be embedded in concrete accurately and hold in correct position while the concrete is placed or, if indicated, form recesses or blockouts in the concrete. Thoroughly clean the surfaces of metalwork in contact with or embedded in concrete.

F. Seat angles, supports and guides: Set seat angles for grating and supports for floor plates so that they maintain the grating and floor plates flush with the floor.

G. Ladder Safety Post: Comply with manufacturer's installation instructions.

H. Pipe Sleeves: Provide where pipes pass through concrete or masonry. Holes drilled with a rotary drill may be provided in lieu of sleeves in existing walls. Provide a center flange for water stoppage on sleeves in exterior or water bearing walls. Provide a rubber caulking sealant or a modular mechanical unit to form a watertight seal in the annular space between pipes and sleeves.

I. Safety Nosings: Unless otherwise specified, safety stair nosing shall be installed on concrete stairs. Nosing shall be secured to concrete with suitable anchors at 15 inches on center and not more than 4 inches from the ends. 1/8 inch thick rubber tape shall be provided at both ends and cut to fit shape of nosing prior to concrete placement.

J. Fastening to Construction-In-Place: Provide anchorage devices and fasteners where necessary for fastening fabricated items to construction-in-place. Design anchorage devices in accordance with Section 01 73 24. Anchor bolts to be in accordance with Section 05 05 20.

K. Set steel stair baseplates on wedges, or shims. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with edge of bearing plate before packing with grout.

L. Railing: Adjust railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing required by design loads and as limited on Drawings. Plumb posts in each direction.

3.04 REPAIR/RESTORATION

A. Galvanized
   1. Maximum area to be repaired shall not be more than 1/2 of 1 percent of the surface area or 36 sq. in. per ton of piece weight, whichever is less. Damage in excess of this requirement shall be repaired by stripping and recoating entire piece.
   2. Clean damaged areas to SSPC-SP5. Repair with zinc-rich paint in accordance with the manufacturer's instructions and with ASTM A780, Annex A2. Minimum thickness requirements shall be in accordance with ASTM A123.
   3. Use zinc-rich repair paint. Acceptable manufacturers:
      a. LPS, Cold Galvanize
      b. ZRC Worldwide, ZRC Galvilite
      c. Approved Equal

B. Painted
   1. After installation, clean and touch up damaged areas with the same materials used for the shop coat.

3.05 FIELD QUALITY CONTROL

A. Electrolytic Protection

B. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings, or isolators. Aluminum in contact with concrete or grout shall be protected with a heavy coat of bituminous paint.

C. Stainless Steel
   1. During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.
   2. After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.
   3. Remove contamination in accordance with requirements of ASTM A380.
   4. Brushes used to remove foreign substances shall utilize only stainless steel or nonmetallic bristles.

END OF SECTION

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SECTION 05 52 10

ALUMINUM RAILINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Prefabricated anodized aluminum component type guardrail and handrail systems; herein referred to as railing.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 03 30 00 Cast-in-Place Concrete.

1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
Aluminum Design Manual	The Aluminum Association, Aluminum Design Manual with Specifications and Guidelines for Aluminum Structures
ASTM B209	Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B210	Aluminum and Aluminum-Alloy Drawn Seamless Tubes
ASTM B221	Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B429	Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM B483	Aluminum and Aluminum-Alloy Drawn Tube and Drawn Pipe for General Purpose Applications
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
AWS D1.2	Structural Welding Code, Aluminum
OSHA	U.S. Dept. of Labor, Occupational Safety and Health Administration
IBC	International Building Code with local amendments

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
4. Layout, installation, and detailed shop drawings for railing.
5. Design calculations stamped and signed by a licensed professional engineer in the State of Arizona. Railing and base support connections to be designed by the Contractor incorporating specified criteria and provisions in the current building code with local governing amendments.

B. Informational Submittals:
1. Material certification for compliance with this specification for aluminum and stainless steel materials.

1.05 QUALITY ASSURANCE

A. General:
1. Railing shall conform to the standards of the Occupational Safety and Health Administration (OSHA) and International Building Code.

1.06 DELIVERY, STORAGE AND HANDLING

A. Cushion wrap complete rails, modules and components to prevent scratching and denting during shipment, storage, and installation.

B. Leave wrap intact, insofar as possible, until railing is completely installed.

PART 2 PRODUCTS

2.01 PERFORMANCE/DESIGN CRITERIA

A. Railing assembly and attachments shall resist a minimum uniform load of 50 pounds per linear foot on the top rail and a concentrated load of 200 pounds (not acting concurrently with the uniform load) applied in any direction. Contractor's supplier and engineer are responsible for designing the guardrail/handrail system along with its base support and anchor bolt size and embedment depth into concrete, or connection to metal framing, to resist the above loading condition taking into account anchor edge distances and concrete strengths at the point of attachment. Contractor shall submit calculations signed and sealed by a professional engineer in the State of Arizona.

B. Thermal Movements: Provide railing that allow for thermal movements resulting from the project site maximum range in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.

2.02 MANUFACTURERS

A. Julius Blum & Co., Inc.

B. Golden Railing Inc.

C. Moultrie Manufacturing.

D. American Railing Systems, Inc.

E. Approved equal.

2.03 MATERIALS

Component	Material
Aluminum pipe	ASTM B210 Alloy 65060-T832; ASTM B 221 Alloy 6063-T5/T52; ASTM B 429, Alloy 6063-T832; ASTM B483, Alloy T832
Aluminum plate	ASTM B209, Alloy 6061-T6
Stainless steel bolts	ASTM A593, Type 316
Stainless steel nuts and washers	ASTM A594, Type316

2.04 CONFIGURATION/COMPONENTS

A. Guard Top Rails: Minimum 1 1/2 inch nominal diameter pipe, Schedule 40.

B. Intermediate Rails: Minimum 1 1/2 inch nominal diameter pipe, Schedule 40.

C. Handrails: 1 1/2 inch nominal diameter pipe, Schedule 40.

D. Posts: Minimum 1 1/2 inch nominal diameter pipe, Schedule 80.

E. Provide manufacturer’s heavy-duty base fitting with stainless steel set screws.

F. Provide aluminum toe boards at guardrails, except where concrete curbs are indicated. Aluminum toe boards shall be minimum 3/16-inch thick plate, connected to the posts.

G. Bolts, including anchor bolts, shall be Type 316 stainless steel.

H. Fittings:
   1. Fittings shall be cast aluminum elbows, T-shapes, post brackets and escutcheons. Provide adapter and anchor plugs as required for a complete installation.
   2. Floor sleeves for removable railing shall be stainless steel, embedded in concrete.

2.05 ASSEMBLY/FABRICATION

A. Pipe cuts shall be clean, straight, square and accurate for minimum joint gap. Work shall be done in conformance with the guardrail and handrail manufacturer's instructions. Work shall be free from blemishes, defects, and misfits of any type which can affect durability, strength, or appearance.

B. Guardrailing and handrailing shall be connected by screws or bolts or welding. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Wherever needed because of the thickness of the metal, holes shall be subpunched and reamed or drilled. Components with mismatched holes shall be replaced. No drifting of bolts or enlargement of holes will be allowed to correct misalignment.

C. Supply components required for anchorage of fabrications.

D. Where shop welding is used, grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints tight and flush. Round exposed edges to small, uniform radius. Use filler alloy rods that will not discolor when anodized, such as ER 5154, ER 5254, ER 5183, ER 5356 or ER 5556 filler alloy rods.

2.06 ISOLATION COATING

A. Isolation coating shall be applied to all aluminum surfaces in contact with concrete, masonry, or dissimilar metals. Use a heavy coat of bituminous paint.

2.07 FINISHES

A. Anodized in accordance with the Aluminum Association AA-M12-C22-A41. Anodize exposed prefabricated components, except stainless steel fasteners, after fabrication.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and accept existing conditions before beginning work.

B. Field verify measurements for railings before fabrication.

3.02 INSTALLATION

A. Install in accordance with manufacturer's written instructions.

B. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings, or isolators. Aluminum in contact with concrete or grout shall be protected with a heavy coat of bituminous paint.

C. Accurately place metal to be embedded in concrete and hold in correct position while the concrete is placed. Where recesses or blockouts are formed in the concrete, grout metalwork in place after concrete has attained its design strength in accordance with Section 03 30 00.

D. Unless otherwise indicated, field welding of railing is not permitted.

3.03 TOLERANCES

A. Maximum variance from plumb: 1/4 inch.

B. Maximum offset from true alignment: 1/4 inch.

END OF SECTION

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SECTION 05 53 10

METAL GRATINGS AND STAIR TREADS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Aluminum, galvanized steel, and stainless steel bar grating and stair treads.

1.02 RELATED SECTIONS

A. This section contains references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 03 30 00 Cast-In-Place Concrete.
   2. Section 05 05 14 Hot-Dip Galvanizing.

1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM A123	Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A380	Cleaning, Descaling, and Passivation of Stainless Steel
ASTM A666	Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
ASTM A1011	Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, and High-Strength Low-Alloy
ASTM B221	Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ANSI/NAAMM	Metal Bar Grating Design Manual

1.04 DEFENITIONS

A. Galvanize: Hot-dip galvanize per ASTM A123 or ASTM A153, per Section 05 05 14.

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
4. Shop drawings showing placing plans for grating.
    a. Provide layout and fabrication details of support frames.
    b. Provide panel layout with individual panel dimensions.
5. Manufacturer's product data with load tables.

PART 2 PRODUCTS

2.01 MATERIALS

Component	Material
Aluminum grating bearing and cross bars	ASTM B221, alloy 6061
Steel grating bearing and cross bars	ASTM A1011, mild carbon steel
Stainless steel grating	ASTM A167 or A666, alloy 316L

2.02 ASSEMBLY/FABRICATION

A. Welds:
    1. Grind smooth rough welds and sharp metal edges. Make welds exposed to view uniform and neat.
    2. Prior to galvanizing, sandblast welds.

B. Clearance: provide ¼" separation between panels and at bearing ends of panel to support frame.

C. Grating:
    1. General
        a. Provide serrated grating for slip resistance.
        b. Bearing bars and cross bars are continuous.
        c. Openings shall be banded with bars having the same dimensions as the bearing bars. Band perimeter edges with bars flush at the top surface of the grating and 1/4 inch clear of the bottom surface.
        d. Bars terminating against edge bars shall be welded to the edge bars when welded construction is used.
        e. When crimped or swaged construction is used, bars at edges shall protrude a maximum of 1/16 inch and be peened or ground to a smooth surface.
        f. Fabrication methods employing bending or notching of bearing or cross bars is not permitted.
        g. Maximum grating panel weigh shall not exceed 80 pounds.

2. Aluminum Grating
    a. Fabricate grating with a mill class 1 clear anodized finish. Punch bearing bars to receive cross bars. After insertion in the bearing bars, cross bars are deformed by a hydraulic press or similar means to permanently lock the bars into the bearing bar openings.
3. Steel Grating
    a. Use only where specified. Hot-dip galvanized finish after fabrication.
4. Stainless Steel Grating
    a. Use only where specified. Stainless steel grating to be cleaned, descaled, and passivated after fabrication in accordance with ASTM A380.

D. Stair Treads:
1. Treads shall match the grating material and type furnished for landings. Use serrated surface for slip resistance. Provide abrasive nosing's on each tread. Provide carrier angle at each end for attachment to stair stringers. Attach components to support members with Type 316 stainless steel fasteners.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and accept existing conditions before beginning work.

B. Field measure grating for proper cutouts and sizes prior to fabrication.

3.02 INSTALLATION

A. Fieldwork is not permitted on galvanized items.

B. Drilling of bolts or enlargement of holes to correct misalignment is not permitted.

C. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings, or isolators. Protect aluminum in contact with concrete with a heavy coat of bituminous paint.

D. Use stainless steel metalwork to be embedded in concrete. Clean surfaces in contact with or embedded in concrete and hold in correct position while concrete is placed. Or, provide formed recesses or blackouts in concrete and then, after concrete has attained design strength, grout metalwork in-place using non-shrink grout.

3.03 REPAIR

A. Repair damaged surfaces of galvanized metals per Section 05 05 14.

END OF SECTION

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SECTION 06 10 00

ROUGH CARPENTRY

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Wood blocking and nailers.
   2. Wood furring.

1.02 ACTION SUBMITTALS

A. Product Data:
   1. For each type of process and factory-fabricated product.
   2. For preservative-treated wood products.

1.03 INFORMATIONAL SUBMITTALS

A. Material Certificates:
   1. For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
   2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.

B. Evaluation Reports: For the following, from ICC-ES:
   1. Wood-preservative-treated wood.
   2. Fire-retardant-treated wood.
   3. Power-driven fasteners.
   4. Post-installed anchors.

PART 2 PRODUCTS

2.01 WOOD PRODUCTS, GENERAL

A. Lumber: Comply with DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
   1. Factory mark each piece of lumber with grade stamp of grading agency.
   2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.
   3. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content:
   1. Boards: 19 percent.
   2. Dimension Lumber: 19 percent unless otherwise indicated.

2.02 PRESERVATIVE TREATMENT

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
   1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat all rough carpentry unless otherwise indicated.

2.03 FIRE-RETARDANT-TREATMENT

A. General: Where fire-retardant-treated materials are indicated, materials are to comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
   1. Exterior Type: Treated materials are to comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
   2. Interior Type A: Treated materials are to have a moisture content of 28 percent or less when tested according to ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.

C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent. Kiln-dry plywood after treatment to maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

E. Application: Treat all rough carpentry unless otherwise indicated.

2.04 MISCELLANEOUS LUMBER

A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
   1. Blocking.
   2. Nailers.
   3. Furring.

B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.

C. Concealed Boards: 19 percent maximum moisture content and any of the following species and grades:
   1. Western woods; Construction or No. 2 Common grade; WCLIB or WWPA.

2.05 FASTENERS

A. General: Fasteners are to be of size and type indicated and comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches into wood substrate.
   1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.

B. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

C. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 ICC-ES AC58 ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate.

2.06 MISCELLANEOUS MATERIALS

A. Adhesives for Gluing Furring to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.

C. Do not splice structural members between supports unless otherwise indicated.

D. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

E. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

F. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
   1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code (IBC).
   2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
   3. ICC-ES evaluation report for fastener.

3.02 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

SECTION 06 16 00

SHEATHING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Composite nail base insulated roof sheathing.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product.

1.03 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:
   1. Wood-preservative-treated plywood.
   2. Fire-retardant-treated plywood.

PART 2 PRODUCTS

2.01 WOOD PANEL PRODUCTS

A. Emissions: Products are to meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.02 PRESERVATIVE-TREATED PLYWOOD

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.

B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

C. Application: Treat all plywood unless otherwise indicated.

2.03 FIRE-RETARDANT-TREATED PLYWOOD

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
   1. Exterior Type: Treated materials are to comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering in accordance with ASTM D2898. Use for exterior locations and where indicated.
   2. Design Value Adjustment Factors: Treated lumber plywood is to be tested in accordance with ASTM D5516 and design value adjustment factors are to be calculated in accordance with ASTM D6305. Span ratings after treatment are to be not less than span ratings specified.

C. Kiln-dry material after treatment to a maximum moisture content of 15 percent.

D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.

E. Application: Treat all plywood unless otherwise indicated.

2.04 COMPOSITE NAIL BASE INSULATED ROOF SHEATHING

A. Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing: ASTM C1289, Type V with DOC PS 2, Exposure 1 oriented strand board on one face.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Atlas Molded Products, a division of Atlas Roofing Corporation.
      b. Cornell Performance Building Products, a Subsidiary of GAF.
      c. Johns Manville; a Berkshire Hathaway company.
      d. Rmax, Inc.
      e. The Dow Chemical Company.
   2. Polyisocyanurate-Foam Thickness: 4 inches.
   3. Oriented-Strand-Board Nominal Thickness: 5/8 inch.

2.05 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. For roof sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:
   1. Table 2304.10.1, "Fastening Schedule," in the ICC's International Building Code.
   2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in the ICC's International Residential Code for One- and Two-Family Dwellings.
   3. ICC-ES evaluation report for fastener.

D. Coordinate roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

3.02 WOOD STRUCTURAL PANEL INSTALLATION

A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.

B. Fastening Methods: Fasten panels as indicated below:
   1. Roof Sheathing:
      a. Screw to cold-formed metal framing.
      b. Space panels 1/8 inch apart at edges and ends.

END OF SECTION

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SECTION 06 41 16

PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Plastic-laminate-clad architectural cabinets.
   2. Plastic-laminate-clad countertops.
   3. Cabinet hardware and accessories.
   4. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-clad architectural cabinets that are not concealed within other construction.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. Shop Drawings:
   1. Include plans, elevations, sections, and attachment details.

C. Samples: For each exposed product and for each color and texture specified.

1.03 INFORMATIONAL SUBMITTALS

A. Research reports.

B. Field quality control reports.

1.04 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1.05 FIELD CONDITIONS

A. Environmental Limitations without Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

B. Environmental Limitations with Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 20 and 50 percent during the remainder of the construction period.

PART 2 PRODUCTS

2.01 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.

B. Architectural Woodwork Standards Grade: Custom.

C. Type of Construction: Frameless.

D. Door and Drawer-Front Style: Flush overlay.

E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Formica Corporation.
   b. Laminart LLC.
   c. Pionite; a Panolam Industries International, Inc. brand.
   d. Wilsonart LLC.

F. Laminate Cladding for Exposed Surfaces:

1. Horizontal Surfaces: Grade HGS.
2. Postformed Surfaces: Grade HGP.
3. Vertical Surfaces: Grade HGS.
4. Edges: Grade HGS.

G. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.

H. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners.

I. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As selected by Architect from laminate manufacturer's full range in the following categories:
   a. Solid colors, matte finish.
   b. Patterns, mattefinish.

2.02 PLASTIC-LAMINATE-CLAD COUNTERTOPS

A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of plastic-laminate-clad countertops indicated for construction, finishes, installation, and other requirements.

B. Grade: Custom.

C. High-Pressure Decorative Laminate: NEMA LD 3, Grade HGS.

D. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
   1. As selected by Architect from manufacturer's full range in the following categories:
      a. Solid colors, matte finish.
      b. Patterns, matte finish.

E. Edge Treatment: Same as laminate cladding on horizontal surfaces.

F. Core Material: Particleboard or MDF.

G. Core Thickness: 3/4 inch.
   1. Build up countertop thickness to 1-1/2 inches at front, back, and ends with additional layers of core material laminated to top.

H. Backer Sheet: Provide plastic-laminate backer sheet, NEMA LD 3, Grade BKL, on underside of countertop substrate.

I. Paper Backing: Provide paper backing on underside of countertop substrate.

2.03 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
   1. Wood Moisture Content: 5 to 10 percent.

B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
   1. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.
   2. Particleboard (Medium Density): ANSI A208.1, Grade M-2.
   3. Softwood Plywood: DOC PS 1, medium-density overlay.
   4. Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.

2.04 FIRE-RETARDANT-TREATED MATERIALS

A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials that are acceptable to authorities having jurisdiction as determined by testing performed on identical products by a qualified testing agency.
   1. Use treated materials that comply with requirements of referenced quality standard. Do not use materials that are warped, discolored, or otherwise defective.
   2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
   3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.

2.05 CABINET HARDWARE AND ACCESSORIES

A. Butt Hinges: 2-3/4-inch, five-knuckle steel hinges made from 0.095-inch-thick metal, and as follows:
   1. Semiconcealed Hinges for Flush Doors: ANSI/BHMA A156.9, B01361.
   2. Semiconcealed Hinges for Overlay Doors: ANSI/BHMA A156.9, B01521.

B. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, 100 degrees of opening.

C. Back-Mounted Pulls: ANSI/BHMA A156.9, B02011.

D. Wire Pulls: Back mounted, solid metal, 4 inches long, 5/16 inch in diameter.

E. Shelf Rests: ANSI/BHMA A156.9, B04013; metal.

F. Drawer Slides: ANSI/BHMA A156.9.
   1. Standard Duty (Grade 1 and Grade 2): Side mount and extending under bottom edge of drawer.
      a. Type: Full extension.
      b. Material: Aluminum slides.
      c. Motion Feature: Soft close dampener.

G. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.

H. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for ANSI/BHMA finish number indicated.
   1. Satin Stainless Steel: ANSI/BHMA 630.

I. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.06 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln-dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

C. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement.
   1. Adhesive for Bonding Edges: Hot-melt adhesive.

2.07 CABINET FABRICATION

A. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

B. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

2.08 COUNTERTOP FABRICATION

A. Fabricate countertops to dimensions, profiles, and details indicated. Provide front and end overhang of 1 inch over base cabinets. Ease edges to radius indicated for the following:
   1. Solid-Wood (Lumber) Members: 1/16 inch unless otherwise indicated.

B. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

PART 3 EXECUTION

3.01 CABINET INSTALLATION

A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

B. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.

C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.

D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.
   1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with No. 10 wafer-head screws sized for not less than 1-1/2-inch penetration into wood framing, blocking, or hanging strips.

3.02 COUNTERTOP INSTALLATION

A. Grade: Install countertops to comply with same grade as item to be installed.

B. Assemble countertops and complete fabrication at Project site to the extent that it was not completed in the shop.
1. Provide cutouts for appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
2. Seal edges of cutouts by saturating with varnish.

C. Field Jointing: Where possible, make in the same manner as shop jointing, using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required. Locate field joints where shown on Shop Drawings.
1. Secure field joints in countertops with concealed clamping devices located within 6 inches of front and back edges and at intervals not exceeding 24 inches. Tighten in accordance with manufacturer's written instructions to exert a constant, heavy-clamping pressure at joints.

D. Scribe and cut countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

E. Countertop Installation: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
1. Install countertops level and true in line. Use concealed shims as required to maintain not more than a 1/8-inch-in-96-inches variation from a straight, level plane.
2. Secure backsplashes to walls with adhesive.
3. Seal joints between countertop and backsplash, if any, and joints where countertop and backsplash abut walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.

F. Protection: Provide Kraft paper or other suitable covering over countertop surfaces, taped to underside of countertop at a minimum of 48 inches o.c. Remove protection at Substantial Completion.

END OF SECTION

SECTION 07 19 00

WATER REPELLENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes penetrating water-repellent treatments for the following vertical and horizontal surfaces:
   1. Cast-in-place concrete.
   2. Concrete unit masonry.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of water repellent and substrate indicated.

1.04 INFORMATIONAL SUBMITTALS

A. Product certificates.

1.05 QUALITY ASSURANCE

A. Applicator Qualifications: An employer of workers trained and approved by manufacturer.

PART 2 PRODUCTS

2.01 PENETRATING WATER REPELLENTS

A. Penetrating Water Repellent: Clear, solvent-based silicone elastomer.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide PROSOCO, Inc; Sure Klean Weather Seal Blok-Guard & Graffiti Control or a comparable product by one of the following:
      a. Advanced Chemical Technologies, Inc.
      b. Chemical Products Industries, Inc.
      c. Dayton Superior Corporation.
      d. Euclid Chemical Company (The); an RPM company.
      e. Pecora Corporation.
      f. Tnemec Company, Inc.
      g. W. R. Meadows, Inc.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements and conditions affecting performance of the Work.
   1. Verify that surfaces are clean and dry according to water-repellent manufacturer's requirements. Check moisture content in representative locations by method recommended by manufacturer.
   2. Verify that there is no efflorescence or other removable residues that would be trapped beneath the application of water repellent.
   3. Verify that required repairs are complete, cured, and dry before applying water repellent.

B. Test pH level according to water-repellent manufacturer's written instructions to ensure chemical bond to silica-containing or siliceous minerals.

3.02 PREPARATION

A. New Construction and Repairs: Allow concrete and other cementitious materials to age before application of water repellent, according to repellent manufacturer's written instructions.

B. Cleaning: Before application of water repellent, clean substrate of substances that could impair penetration or performance of product according to water-repellent manufacturer's written instructions.

C. Coordination with Mortar Joints: Do not apply water repellent until pointing mortar for joints adjacent to surfaces receiving water-repellent treatment has been installed and cured.

D. Coordination with Sealant Joints: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.
   1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those required.

3.03 APPLICATION

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect the substrate before application of water repellent and to instruct Applicator on the product and application method to be used.

B. Apply coating of water repellent on surfaces to be treated using low-pressure spray to the point of saturation. Apply coating in dual passes of uniform, overlapping strokes. Remove excess material; do not allow material to puddle beyond saturation. Comply with manufacturer's written instructions for application procedure unless otherwise indicated.

C. Apply a second saturation coating, repeating first application. Comply with manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult manufacturer's technical representative if written instructions are not applicable to Project conditions.

3.04 CLEANING

A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Correct damage to work of other trades caused by water-repellent application.

B. Comply with manufacturer's written cleaning instructions.

END OF SECTION

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SECTION 07 21 00

THERMAL INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Extruded polystyrene foam-plastic board insulation.

1.02 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Extruded polystyrene foam-plastic board insulation.

1.03 INFORMATIONAL SUBMITTALS

A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.
   1. Sign, date, and post the certification in a conspicuous location on Project site.

B. Product test reports.

C. Research reports.

PART 2 PRODUCTS

2.01 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION

A. Extruded Polystyrene Board Insulation, Type IV: ASTM C578, Type IV, 25-psi minimum compressive strength; unfaced.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Owens Corning; Foamular NGX CW25 XPS Insulation or comparable product by another manufacturer.
   2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
   3. Smoke-Developed Index: Not more than 450 when tested in accordance with ASTM E84.
   4. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
   5. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

2.02 ACCESSORIES

A. Insulation for Miscellaneous Voids:
   1. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.

B. Insulation Anchors, Spindles, and Standoffs: As recommended by manufacturer.

C. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Install insulation with manufacturer's R-value label exposed after insulation is installed.

D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

E. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.02 INSTALLATION OF FOUNDATION WALL INSULATION

A. Butt panels together for tight fit.

B. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

3.03 INSTALLATION OF CAVITY-WALL INSULATION

A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face and as recommended by manufacturer.
   1. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions, and with faces flush.
   2. Press units firmly against inside substrates.
   3. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 042000 "Unit Masonry."

END OF SECTION

SECTION 07 41 13

STANDING-SEAM METAL ROOF PANELS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Standing-seam metal roof panels.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.

C. Samples: For each type of metal panel indicated.

1.04 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Warranties: Sample of special warranties.

1.05 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

1.07 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Finish Warranty Period: 20 years from date of Substantial Completion.

C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.
   1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Energy Performance:
   1. Provide roof panels that are listed on the EPA/DOE's ENERGY STAR "Roof Product List" for steep-slope roof products.
   2. Provide roof panels according to one of the following when tested according to CRRC-1:
      a. Three-year, aged solar reflectance of not less than 0.55 and emissivity of not less than 0.75.
      b. Three-year, aged Solar Reflectance Index of not less than 64 when calculated according to ASTM E1980.

B. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
   1. Wind Loads and Other Design Loads: Refer to Section 01 73 24.
   2. Deflection Limits: For wind loads, no greater than 1/180 of the span.

C. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E1680 at the following test-pressure difference:
   1. Test-Pressure Difference: 6.24 lbf/sq. ft.

D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E1646 at the following test-pressure difference:
   1. Test-Pressure Difference: 6.24 lbf/sq. ft.

E. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E2140.

F. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
   1. Uplift Rating: UL 90.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.02 STANDING-SEAM METAL ROOF PANELS

A. Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
   1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.

B. Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and a flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Berridge Manufacturing Company; Berridge Zee-Lock Double Lock or a comparable product by one of the following:
      a. AEP Span a brand of ASC Profiles LLC, a part of BlueScope.
      b. ATAS International, Inc.
      c. Fabral; a brand of OmniMax International.
      d. MBCI; Cornerstone Building Brands.
      e. Metal Sales Manufacturing Corporation.
      f. PAC-CLAD; Petersen Aluminum Corporation; a Carlisle company.
      g. Ultra Seam, Inc.
   2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
      a. Nominal Thickness: 0.028 inch.
      b. Exterior Finish: Two-coat fluoropolymer.
      c. Color: As selected by Architect from manufacturer's full range.
   3. Clips: One-piece fixed.
   4. Material:
      a. 0.028-inch- nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
   5. Joint Type: Double folded.
   6. Panel Coverage: 16 inches.
   7. Panel Height: 2.0 inches.

2.03 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 40 mils thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
   1. Thermal Stability: Stable after testing at 240 deg F; ASTM D1970.
   2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D1970.
   3. Basis-of-Design Product: Subject to compliance with requirements, provide Grace Ice & Watershield HT or a comparable product by one of the following:
      a. Tamko.
      b. Mid-States Asphalt.
      c. Soprema.
      d. MFM.
      e. Polyglass.

B. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.04 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C645; cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 hot-dip galvanized coating designation or ASTM A792/A792M, Class AZ50 coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
   1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
   2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
   3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Gutters and Downspouts: Formed from same material as roof panels according to SMACNA's "Architectural Sheet Metal Manual." Finish to match metal roof panels, roof fascia and rake trim.

E. Panel Fasteners: Self-tapping screws designed to withstand design loads.

F. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
   1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing; 1/2 inch wide and 1/8 inch thick.
   2. Joint Sealant: ASTM C920; as recommended in writing by metal panel manufacturer.
   3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.05 FABRICATION

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

2.06 FINISHES

A. Panels and Accessories:
   1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat.
   2. Concealed Finish: White or light-colored acrylic or polyester backer finish.

PART 3 EXECUTION

3.01 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.02 INSTALLATION OF UNDERLAYMENT

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.
   1. Apply over the entire roof surface.

B. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels.

C. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 076200 "Sheet Metal Flashing and Trim."

3.03 INSTALLATION OF STANDING-SEAM METAL ROOF PANELS

A. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
   1. Install clips to supports with self-tapping fasteners.
   2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
   3. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
   4. Watertight Installation:
      a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
      b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
      c. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.

B. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

C. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

3.04 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

END OF SECTION

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SECTION 07 42 93

SOFFIT PANELS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Metal soffit panels.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.

C. Samples: For each type of metal panel indicated.

1.03 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Warranties: Samples of special warranties.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.05 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
   1. Wind Loads and Other Design Loads: Refer to Section 01 73 24.
   2. Deflection Limits: For wind loads, no greater than 1/180 of the span.

B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E283 at the following test-pressure difference:
   1. Test-Pressure Difference: 6.24 lbf/sq. ft.

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at the following test-pressure difference:
   1. Test-Pressure Difference: 6.24 lbf/sq. ft.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.02 METAL SOFFIT PANELS

A. Provide metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.

B. Metal Soffit Panels: Match profile and material of metal roof panels.
   1. Finish: Match finish and color of metal roof panels.
   2. Sealant: Factory applied within interlocking joint.

C. Flush-Profile Metal Soffit Panels: Solid panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced between panel edges; with flush joint between panels.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Berridge Manufacturing Company; Berridge FW-12 Panel or a comparable product by one of the following:
      a. AEP Span a brand of ASC Profiles LLC, a part of BlueScope.
      b. ATAS International, Inc.
      c. Fabral; a brand of OmniMax International.
      d. MBCI; Cornerstone Building Brands.
      e. Metal Sales Manufacturing Corporation.
      f. PAC-CLAD; Petersen Aluminum Corporation; a Carlisle company.
      g. Ultra Seam, Inc.
   2. Material: Same material, finish, and color as metal roofpanels.
   3. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
      a. Nominal Thickness: 0.028 inch.
      b. Exterior Finish: Two-coat fluoropolymer.
      c. Color: As selected by Architect from manufacturer's full range.

4. Panel Coverage: 12 inches.
5. Panel Height: 1.5 inches.

2.03 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 coating designation or ASTM A792/A792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
   1. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

E. Panel Sealants: Provide sealant types recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
   1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing; 1/8 inch thick.
   2. Joint Sealant: ASTM C920; as recommended in writing by metal panel manufacturer.
   3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.04 FABRICATION

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

2.05 FINISHES

A. Panels and Accessories:
   1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   2. Concealed Finish: White or light-colored acrylic or polyester backer finish.

PART 3 EXECUTION

3.01 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.
   1. Soffit Framing: Wire tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

3.02 INSTALLATION

A. Metal Soffit Panels: Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
   1. Apply panels and associated items true to line for neat and weathertight enclosure.
   2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal panels.
   3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
   4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.

B. Watertight Installation:
   1. Apply a continuous ribbon of sealant or tape to seal lapped joints of metal panels, using sealant or tape as recommend by manufacturer on side laps of nesting-type panels and elsewhere as needed to make panels watertight.
   2. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
   3. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.

C. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

D. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

3.03 CLEANING

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

END OF SECTION

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SECTION 07 62 00

SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Formed roof-drainage sheet metal fabrications.
   2. Formed steep-slope roof sheet metal fabrications.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS

A. Product Data: For each of the following
   1. Elastomeric sealant.
   2. Butyl sealant.

B. Shop Drawings: For sheet metal flashing and trim.
   1. Include plans, elevations, sections, and attachment details.
   2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
   3. Include identification of material, thickness, weight, and finish for each item and location in Project.
   4. Include details for forming, including profiles, shapes, seams, and dimensions.
   5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
   6. Include details of termination points and assemblies.
   7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
   8. Include details of roof-penetration flashing.
   9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
   10. Include details of special conditions.
   11. Include details of connections to adjoining work.

C. Samples: For each exposed product and for each color and texture specified, 12 inches long by actual width.

1.04 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.05 CLOSEOUT SUBMITTALS

A. Maintenance data.

B. Special warranty.

1.06 QUALITY ASSURANCE

A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1.07 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
      b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.02 SHEET METALS

A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet in accordance with ASTM A653/A653M, G90 coating designation; prepainted by coil-coating process to comply with ASTM A755/A755M.
   1. Surface: Smooth, flat.
   2. Exposed Coil-Coated Finish:
      a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   3. Color: As selected by Architect from manufacturer's full range.
   4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

2.03 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal.
   1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
      a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
      b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
      c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
   2. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

D. Elastomeric Sealant: ASTM C920, elastomeric polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

F. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.

G. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.

2.04 FABRICATION, GENERAL

A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
   1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
   2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
   3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
   4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
   5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:
   1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
   2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.

C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
   1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
   2. Use lapped expansion joints only where indicated on Drawings.

D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Seams:
   1. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

2.05 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters:
   1. Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required.

2. Fabricate in minimum 96-inch-long sections.
3. Furnish flat-stock gutter brackets and flat-stock gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard, but with thickness not less than twice the gutter thickness.
4. Fabricate expansion joints, expansion-joint covers, and gutter accessories from same metal as gutters.
5. Gutters with Girth up to 15 Inches: Fabricate from the following materials:
   a. Galvanized Steel: 0.028 inch thick.

B. Downspouts: Fabricate rectangular downspouts to dimensions indicated on Drawings, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors. Shop fabricate elbows.
1. Fabricate from the following materials:
   a. Galvanized Steel: 0.028 inch thick.

2.06 STEEP-SLOPE ROOF SHEET METAL FABRICATIONS

A. Drip Edges: Fabricate from the following materials:
1. Galvanized Steel: 0.028 inch thick.

B. Eave, Rake Flashing: Fabricate from the following materials:
1. Galvanized Steel: 0.028 inch thick.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.
1. Install fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of sealant.
3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
5. Install continuous cleats with fasteners spaced not more than 12 inches o.c.
6. Space individual cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
8. Do not field cut sheet metal flashing and trim by torch.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
   1. Coat concealed side of sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
   2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
   1. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
   2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
   3. Use lapped expansion joints only where indicated on Drawings.

D. Fasteners: Use fastener sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction.
   1. Use sealant-filled joints unless otherwise indicated.
      a. Embed hooked flanges of joint members not less than 1 inch into sealant.
      b. Form joints to completely conceal sealant.
      c. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
      d. Adjust setting proportionately for installation at higher ambient temperatures.
         1) Do not install sealant-type joints at temperatures below 40 deg F.
   2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.02 INSTALLATION OF ROOF-DRAINAGE SYSTEM

A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

B. Hanging Gutters:
   1. Join sections with joints sealed with sealant.
   2. Provide for thermal expansion.
   3. Attach gutters at eave or fascia to firmly anchor them in position.
   4. Provide end closures and seal watertight with sealant.
   5. Slope to downspouts.

6. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, 50 feet apart. Install expansion-joint caps.

C. Downspouts:
   1. Join sections with 1-1/2-inch telescoping joints.
   2. Provide hangers with fasteners designed to hold downspouts securely to walls.
   3. Locate hangers at top and bottom and at approximately 60 inches o.c.
   4. Provide elbows at base of downspout to direct water away from building.
   5. Connect downspouts to underground drainage system.

3.03 INSTALLATION OF ROOF FLASHINGS

A. Install sheet metal flashing and trim to comply with performance requirements and cited sheet metal standard.
   1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
   2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless steel draw band and tighten.

C. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.
   1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
   2. Extend counterflashing 4 inches over base flashing.
   3. Lap counterflashing joints minimum of 4 inches.

D. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.04 INSTALLATION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.05 CLEANING

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

3.06 PROTECTION

A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION

SECTION 07 72 53

SNOW GUARDS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Rail-type, seam-mounted snow guards.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.
   1. Include details of rail-type snow guards.

C. Delegated-Design Submittal: For snow guards, include analysis reports signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Include calculation of number and location of snow guards.

1.03 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the jurisdiction in which the Project is located.

B. Product Test Reports: For each type of snow guard, for tests performed by a qualified testing agency, indicating load at failure of attachment to roof system identical to roof system used on this Project.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 45 00 “Contractor Quality Control,” to design snow guards, including attachment to roofing material and roof deck, applicable for attachment method, based on the following:
   1. Roof snow load.
   2. Snow drifting
   3. Roof slope.
   4. Roof type.
   5. Roof dimensions.
   6. Roofing substrate type and thickness.
   7. Snow guard type.
   8. Snow guard fastening method and strength.
   9. Snow guard spacing.

10. Coefficient of Friction Between Snow and Roof Surface: 0.
11. Factor of Safety: 2.

B. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

C. Structural Performance: Snow guards shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
   1. Snow Loads: Refer to Section 01 73 24.

2.02 RAIL-TYPE SNOW GUARDS

A. Rail-Type, Seam-Mounted Snow Guards:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide S-5! Metal Roof Innovations, Ltd.; SnoRail/SnoFence or a comparable product by one of the following:
      a. Alpine SnowGuards.
      b. IceBlox Inc.
      c. LMCurbs.
      d. Rocky Mountain Snow Guards, Inc.
      e. TRA Snow and Sun, Inc.
   2. Description: Snow guard rails fabricated from metal pipes, bars, or extrusions, anchored to brackets and equipped with two rails.
   3. Brackets and Baseplates: ASTM B209 aluminum, clear anodized.
   4. Bars: ASTM B221 aluminum; mill finish.
      a. Profile: Round.
   5. Seam clamps: ASTM B221 aluminum extrusion or ASTM B85/B85M aluminum casting with stainless steel set screws incorporating round nonpenetrating point; designed for use with applicable roofing system to which clamp is attached.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install snow guards according to manufacturer's written instructions.
   1. Space rows as recommended by manufacturer.

B. Attachment for Standing-Seam Metal Roofing:
   1. Do not use fasteners that will penetrate metal roofing or fastening methods that void metal roofing finish warranty.

2. Rail-Type, Seam-Mounted Snow Guards:
   a. Install brackets to vertical ribs in straight rows.
   b. Secure with stainless steel set screws, incorporating round nonpenetrating point, on same side of standing seam.
   c. Torque set screw according to manufacturer's instructions.
   d. Install cross members to brackets.

END OF SECTION

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SECTION 07 91 26

JOINT FILLERS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies preformed joint fillers for isolating concrete elements.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM D994	Preformed Expansion Joint Filler for Concrete (Bituminous Type)
ASTM D1752	Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

PART 2 PRODUCTS

2.01 PREFORMED ASPHALT FIBERBOARD

A. Preformed asphalt fiberboard joint filler shall be in accordance with ASTM D994 and shall be 1/2 inch thick unless otherwise specified.

2.02 PREFORMED RESIN-BONDED CORK

A. Preformed resin-bonded cork joint filler shall be in accordance with ASTM D1752, Type II. Cork joint filler thickness shall match the specified joint width.

2.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Provide manufacturer’s data for the material.
   2. Manufacturer's recommendations for handling and installation of the material.

PART 3 EXECUTION

3.01 GENERAL

A. Preformed joint fillers shall be placed into position before the concrete is poured. Where it is necessary for the filler to be fixed to existing concrete or other building materials, a suitable adhesive recommended by the filler manufacturer shall be used. Filler surfaces shall be clean and dry prior to the placement of the concrete.

3.02 PREFORMED ASPHALT FIBERBOARD

A. Preformed asphalt fiberboard joint fillers shall be used for expansion joints in concrete sidewalks, curbs, and roadways.

3.03 PREFORMED RESIN-BONDED CORK

A. Preformed resin-bonded cork joint filler shall be used for expansion joints in concrete structures. The expansion joint shall be sealed with backer rod and sealant as specified in Section 07 92 00.

END OF SECTION

SECTION 07 92 00

JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Silicone joint sealants.
   2. Urethane joint sealants.
   3. Latex joint sealants.

1.02 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Samples: For each kind and color of joint sealant required.

C. Joint-Sealant Schedule: Include the following information:
   1. Joint-sealant application, joint location, and designation.
   2. Joint-sealant manufacturer and product name.
   3. Joint-sealant formulation.
   4. Joint-sealant color.

1.03 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Preconstruction laboratory test reports.

C. Preconstruction field-adhesion-test reports.

D. Field-adhesion-test reports.

E. Sample warranties.

1.04 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C1021 to conduct the testing indicated.

1.05 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 JOINT SEALANTS, GENERAL

A. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.02 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C1248.

B. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

2.03 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

B. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.

C. Urethane, M, P, 50, T, NT: Multicomponent, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 50, Uses T and NT.

2.04 MILDEW-RESISTANT JOINT SEALANTS

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

C. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.

2.05 JOINT-SEALANT BACKING

A. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.

2.06 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 EXECUTION

3.01 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
   1. Remove laitance and form-release agents from concrete.
   2. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces.

3.02 INSTALLATION OF JOINT SEALANTS

A. General: Comply with ASTM C1193 and joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   1. Provide concave joint profile per Figure 8A in ASTM C1193 unless otherwise indicated.

3.03 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.
   1. Joint Locations:
      a. Isolation and contraction joints in cast-in-place concrete slabs.
      b. Tile control and expansion joints.
      c. Joints between different materials listed above.
      d. Other joints as indicated on Drawings.
   2. Joint Sealant: Urethane, M, P, 50, T, NT.
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
   1. Joint Locations:
      a. Control and expansion joints in unit masonry.
      b. Other joints as indicated on Drawings.
   2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
   1. Joint Locations:
      a. Isolation joints in cast-in-place concrete slabs.
      b. Other joints as indicated on Drawings.
   2. Joint Sealant: Urethane, S, P, 25, T, NT.
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
   1. Joint Locations:
      a. Control and expansion joints on exposed interior surfaces of exterior walls.
      b. Tile control and expansion joints.
      c. Vertical joints on exposed surfaces of unit masonry walls.
      d. Other joints as indicated on Drawings.
   2. Joint Sealant: Urethane, S, NS, 25, NT.
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

E. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.
   1. Joint Locations:
      a. Control joints on exposed interior surfaces of exterior walls.
      b. Perimeter joints between interior wall surfaces and frames of interior doors windows.
      c. Other joints as indicated on Drawings.
   2. Joint Sealant: Acrylic latex.
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

F. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
   1. Joint Locations:
      a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
      b. Tile control and expansion joints where indicated.
      c. Other joints as indicated on Drawings.
   2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

G. Joint-Sealant Application: Concealed mastics.
   1. Joint Locations:
      a. Aluminum thresholds.
      b. Sill plates.
      c. Other joints as indicated on Drawings.
   2. Joint Sealant: Butyl-rubber based.
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION

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SECTION 08 11 13

HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Interior standard steel doors and frames.
   2. Exterior standard steel doors and frames.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include the following:
   1. Elevations of each door type.
   2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
   3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.

C. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.03 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Field quality control reports.

1.04 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.05 QUALITY ASSURANCE

A. Egress Door Inspector Qualifications: Inspector for field quality control inspections of egress door assemblies is to meet the qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:
   1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Ceco Door; AADG, Inc.; ASSA ABLOY.
   2. Curries, AADG, Inc.; ASSA ABLOY Group.
   3. Custom Metal Products.
   4. National Custom Hollow Metal Doors & Frames.
   5. North American Door Corp.
   6. Republic Doors and Frames; a Allegion brand.
   7. Rocky Mountain Metals, Inc.
   8. Steelcraft; Allegion plc.
   9. Stiles Custom Metal, Inc.
   10. West Central Manufacturing, Inc.

2.02 PERFORMANCE REQUIREMENTS

A. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.38 deg Btu/F x h x sq. ft. when tested in accordance with ASTM C1363 or ASTM E1423.

2.03 INTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B.
   1. Doors:
      a. Type: As indicated in the Door and Frame Schedule.
      b. Thickness: 1-3/4 inches.
      c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch.
      d. Edge Construction: Model 2, Seamless.
      e. Core: Manufacturer's standard.
   2. Frames:
      a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch.
      b. Transom Frames: Fabricated from same thickness material as adjacent door frame.
      c. Construction: Full profile welded.

2.04 EXTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A.
   1. Doors:
      a. Type: As indicated in the Door and Frame Schedule.
      b. Thickness: 1-3/4 inches.
      c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A60 coating.
      d. Edge Construction: Model 2, Seamless.
      e. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
      f. Bottom Edges: Close bottom edges of doors with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
      g. Core: Manufacturer's standard.
   2. Frames:
      a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A60 coating.
      b. Construction: Full profile welded.

2.05 FRAME ANCHORS

A. Jamb Anchors:
   1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
   2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
   3. Postinstalled Expansion Anchor: Minimum 3/8-inch-diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
   1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized in accordance with ASTM A153/A153M, Class B.

2.06 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized in accordance with ASTM A153/A153M.

E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

G. Glazing: Comply with requirements in Section 088000 "Glazing."

2.07 FABRICATION

A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
   1. Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding, or by rigid mechanical anchors.
   2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
   3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
      a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
      b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with ANSI/SDI A250.6, the Door Hardware Schedule, and templates.
   1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with miteredhairline joints.
   1. Provide stops and moldings flush with face of door, and with beveled stops unless otherwise indicated.
   2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
   3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
   4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
   5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

2.08 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
   1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 EXECUTION

3.01 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.02 INSTALLATION

A. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.
   1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
      a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
      b. Install frames with removable stops located on secure side of opening.
   2. Floor Anchors: Secure with postinstalled expansion anchors.

a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Solidly pack mineral-fiber insulation inside frames.
4. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors.
5. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
   a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
   c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

B. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
   1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.

C. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.03 FIELD QUALITY CONTROL

A. Inspection Agency: Engagea qualified inspector to perform inspections and to furnish reports to Architect.

B. Inspections:
   1. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

3.04 REPAIR

A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

C. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION

SECTION 08 31 20

FLOOR ACCESS DOORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Factory-fabricated single leaf aluminum floor access doors and frames with water drainage. Include telescoping ladder safety post.

1.02 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM B221	Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B632	Aluminum-Alloy Rolled Tread Plate
ASTM A240	Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
AASHTO	American Association of State Highway and Transportation Officials
OSHA	U.S. Dept. of Labor, Occupational Safety and Health Administration

1.03 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. Statement of experience for both manufacturer and installer.
   5. Fabrication drawings showing layouts, connections to structure, and anchoring details.
   6. Erection and installation drawings showing construction details, reinforcement, anchorage, and installation with relation to the building construction.
   7. Drain pipe layout from the drain coupling to the discharge point.

B. Informational Submittals:
   1. Manufacturer's product data showing conformance to the specification.
   2. Structural calculations for the floor access door design provided by the manufacturer and sealed by a registered professional engineer registered in the State of Arizona.
   3. Instructions for the storage, handling, installation, and operation.
   4. Manufacturer's warranty.

1.04 QUALITY ASSURANCE

A. Manufacturer: Minimum of 5 years' experience manufacturing similar products.

B. Installer: Minimum of 2 years' experience installing similar products.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's original packaging, stored in a dry, protected, well-vented area. Inspect product upon receipt and report damage to carrier and manufacturer.

1.06 SPECIAL WARRANTY

A. Materials shall be free of defects in material and workmanship for a period of 5 years from the date of purchase. Should a part fail to function in normal use within this period, manufacturer shall furnish a new part at no charge.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following manufacturers are acceptable. The manufacturer's standard product may require modification to conform to specified requirements.
   1. The Bilco Company.
   2. Babcock Davis.
   3. Halliday Products.
   4. East Jordan Iron Works (EJ).
   5. Approved Equal.

2.02 PERFORMANCE/DESIGN CRITERIA

A. Door leafs shall be reinforced to support a minimum live load of 300 psf or AASHTO H-20 wheel load with a maximum deflection of 1/150th of the span. See Floor Access Door Schedule at the end of this section, which indicates loading criteria required at each location.

B. Nominal opening sizes and hinge opening side shall be as noted on the Drawings and in the Floor Access Door Schedule.

2.03 MATERIALS

A. Access doors, single leaf or double leaf: 1/4 inch minimum aluminum with diamond tread pattern; ASTM B632, 6061-T6.

B. Channel frame shall be 1/4 inch minimum extruded aluminum with bent down anchor tabs around the perimeter: ASTM B221, 6061-T6.

C. Hardware: ASTM A240 Type 316 stainless steel throughout.

D. Fasteners:
   1. Bolts: ASTM F593
   2. Nuts: ASTM F594

2.04 COMPONENTS/ FEATURES

A. Manufacturer shall provide the required number and size of compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled door leaf operation throughout the entire arc of opening; and to act as a check in retarding downward motion of the cover when closing.

B. Spring tubes shall be constructed of a reinforced nylon 6/6-based engineered composite material. The upper tube shall prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe fastened to a formed 1/4 inch gusset support plate.

C. Door leafs shall be equipped with a hold-open arm which automatically locks the door in the open position. A removable exterior turn/lift handle with a spring loaded ball detent shall be provided to open the door and the latch release shall be protected by a flush, gasketed, removable screw plug. A stainless steel snap lock with fixed handle shall be mounted on the underside of the door.

D. Provide heavy forged aluminum hinges with 1/4 inch minimum diameter stainless steel pins.
   1. Hinges must operate in such a manner to prevent the door leafs from protruding into the channel frame.
   2. Design hinges specifically for horizontal installation.
   3. Hinges shall be through-bolted to the cover with tamperproof stainless steel lock bolts and through-bolted to the frame with stainless steel bolts and locknuts.

E. A continuous ethylene propylene diene monomer (EPDM) gasket shall be mechanically attached to the aluminum frame to create a barrier around the entire perimeter of the cover and significantly reduce the amount of dirt and debris that may enter the channel frame.

F. A 1.5 inch drain coupling shall be provided.

G. Provide a fall protection grating system at all access doors. Manufacturer shall install the grating system when the door is fabricated.
   1. Design Criteria: Meet OSHA 29 CFR 1910.23 requirements for fall protection.

2. Grating panel material: Aluminum with powder coat paint finish.
3. Grating panel color: High visibility OSHA safety yellow or orange.
4. Grating panel shall lock automatically in the full open position.
5. Grating panel shall lift open in the opposite direction as the door(s).
6. Hold open feature: Stainless steel hold open device shall be provided to lock the cover in the fully open 90 degree position.
7. Lift mechanism and hardware: Stainless steel lifting mechanisms as specified above or all fall protection panels that weigh over 50 pounds.
8. Grating openings: Reinforced with easy-open aluminum covers for removal of instrumentation below access doors.

H. Provide safety chain made of non-corrosive material that will span across the corners of double leaf access doors when open.

I. Provide telescoping ladder safety posts for easy, safe ladder access through the access door openings.
1. Material: Stainless steel.
2. Telescoping post to be permanently mounted to the top two rungs of fixed ladders.
3. Post must automatically lock in the fully raised position to provide the user with a firm and steady hand-hold.
4. Post to have release lever that allows the post to be easily lowered to its retracted position.

2.05 FINISHES

A. Door and frame: Mill finish aluminum with heavy bituminous coating where in contact with concrete.

B. Telescopic safety post: aluminum or stainless steel.

C. Springs: Electro-coated acrylic finish.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and openings for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Installation shall conform to the manufacturer’s recommendations.

B. Frame shall be accurately cast in place and securely anchored to concrete. Installation of access doors after concrete is placed is not allowed.

C. Set frame level, plumb and in proper alignment with adjacent work.

D. Contractor shall field route a 1.5 inch Schedule 80 PVC drain pipe from the 1.5 inch drain coupling on all access doors to the water or floor level below. Place drain pipe clear of the access area below the door and as approved by the Owner's Representative.

3.03 REPAIR/RESTORATION

A. Repair finishes damaged during installation.

B. Remove and replace doors that are warped, bowed, or otherwise damaged.

3.04 ADJUSTING

A. Adjust doors and hardware after installation for proper operation.

3.05 CLEANING

A. Clean exposed surfaces using methods acceptable to the manufacturer that will not damage finish.

END OF SECTION

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SECTION 08 33 23

OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Insulated service doors.

B. Related Requirements:
   1. Section 05 50 00 "Metal Fabrications" for miscellaneous steel supports, door-opening framing, corner guards, and bollards.

1.02 ACTION SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.
   1. Include points of attachment and their corresponding static and dynamic loads imposed on structure.

C. Samples: For each exposed product and for each color and texture specified.

1.03 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.04 CLOSEOUT SUBMITTALS

A. Special warranty.

B. Maintenance data.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

1.06 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of doors that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Structural Performance, Exterior Doors: Capable of withstanding the following design wind loads:
   1. Design Wind Load: Refer to Section 01 73 24.
   2. Testing: According to ASTM E330/E330M.

B. Seismic Performance: Overhead coiling doors withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.02 DOOR ASSEMBLY

A. Insulated Service Door: Overhead coiling door formed with curtain of interlocking metal slats.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Clopay Building Products.
      b. Cookson; a CornellCookson company.
      c. Cornell; a CornellCookson company.
      d. Overhead Door Corporation.
      e. Raynor Garage Doors.
      f. Wayne Dalton; a division of Overhead Door Corporation.

B. Operation Cycles: Door components and operators capable of operating for not less than 10,000.

C. Insulated Door Curtain R-Value: 4.5 deg F x h x sq. ft./Btu.

D. Door Curtain Material: Galvanized steel.

E. Door Curtain Slats: Flat profile slats of 1-7/8-inch center-to-center height.
   1. Insulated-Slat Interior Facing: Metal.

F. Bottom Bar: Two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch thick; fabricated from hot-dip galvanized steel and finished to match door.

G. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats.

H. Hood: Match curtain material and finish.
   1. Mounting: Face of wall.

I. Locking Devices: Equip door with locking device assembly.
   1. Locking Device Assembly: Single-jamb side locking bars, operable from inside with thumbturn, outside with cylinder.

J. Manual Door Operator: Chain-hoist operator.

K. Curtain Accessories: Equip door with weatherseals.

L. Door Finish:
   1. Baked-Enamel or Powder-Coated Finish: Color as selected by Architect from manufacturer's full range.
   2. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

2.03 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
   1. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E84 or UL 723. Enclose insulation completely within slat faces.
   2. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face, with minimum steel thickness of 0.010 inch.

B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.

2.04 HOODS

A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.
   1. Exterior-Mounted Doors: Fabricate hood to act as weather protection and with a perimeter sealant-joint-bead profile for applying joint sealant.

2.05 LOCKING DEVICES

A. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
   1. Lock Cylinders: As specified in Section 08 71 00 "Door Hardware" and keyed to building keying system.
   2. Keys: Three for each cylinder.

2.06 CURTAIN ACCESSORIES

A. Weatherseals for Exterior Doors: Equip each exterior door with weather-stripping gaskets fitted to entire exterior perimeter of door for a weather-resistant installation unless otherwise indicated.

2.07 COUNTERBALANCE MECHANISM

A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.08 MANUAL DOOR OPERATORS

A. General: Equip door with manual door operator by door manufacturer.

B. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 25-lbf force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

3.02 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and to furnish reports to Architect.

B. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

C. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

3.03 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION

SECTION 08 45 13

FIBERGLASS WALL PANEL SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes the insulated translucent sandwich panel system and accessories, factory unitized, as shown and specified. Work includes providing and installing:
   1. Flat factory prefabricated structural insulated translucent sandwich panels
   2. Aluminum installation system
   3. Aluminum sill flashing

B. Related Requirements
   1. Section 07 92 00: Joint Sealants

1.02 SUBMITTALS

A. Submit manufacturer's product data. Include construction details, material descriptions, profiles and finishes of components.

B. Submit shop drawings. Include elevations and details.

C. Submit manufacturer's color charts showing the full range of colors available for factory-finished aluminum.
   1. When requested, submit samples for each exposed finish required, in same thickness and material indicated for the work and in size indicated below. If finishes involve normal color variations, include sample sets consisting of two or more units showing the full range of variations expected.
      a. Sandwich panels: 14" x 28" units
      b. Factory finished aluminum: 5" long sections

D. Submit Installer Certificate, signed by installer, certifying compliance with project qualification requirements.

E. Submit product reports from a qualified independent testing agency indicating each type and class of panel system complies with the project performance requirements, based on comprehensive testing of current products. Previously completed reports will be acceptable if for current manufacturer and indicative of products used on this project.
   1. Reports required are:
      a. International Building Code Evaluation Report
      b. Flame Spread and Smoke Developed (UL 723) – Submit UL Card
      c. Burn Extent (ASTM D 635)
      d. Color Difference (ASTM D 2244)
      e. Impact Strength (UL 972)
      f. Bond Tensile Strength (ASTM C 297 after aging by ASTM D 1037)
      g. Bond Shear Strength (ASTM D 1002)

h. Beam Bending Strength (ASTM E 72)
i. Insulation U-Factor (NFRC 100)
j. NFRC System U-Factor Certification (NFRC 700)
k. Solar Heat Gain Coefficient (NFRC or Calculations)
l. Condensation Resistance Factor (AAMA 1503)
m. Air Leakage (ASTM E 283)
n. Structural Performance (ASTM E 330)
o. Water Penetration (ASTM E 331)
p. 1200°F Fire Resistance (SWRI)
q. ASTM E1886/1996 or TAS 201, 202 and 203
r. Performance for Windows (AAMA/WDMA/CSA-101/I.S.2/A440-05)

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications

1. Material and products shall be manufactured by a company continuously and regularly employed in the manufacture of specified materials for a period of at least ten consecutive years and which can show evidence of those materials being satisfactorily used on at least six projects of similar size, scope and location. At least three of the projects shall have been in successful use for ten years or longer.
2. Panel system must be listed by an ANSI accredited Evaluation Service, which requires quality control inspections and fire, structural and water infiltration testing of sandwich panel systems by an accredited agency.

1. Quality control inspections shall be conducted at least once each year and shall include manufacturing facilities, sandwich panel components and production sandwich panels for conformance with AC177 “Translucent Fiberglass Reinforced Plastic (FRP) Faced Panel Wall, Roof and Skylight Systems” as issued by the ICC-ES.

B. Installer’s Qualifications: Installation shall be by an experienced installer, which has been in the business of installing specified panel systems for at least two consecutive years and can show evidence of satisfactory completion of projects of similar size, scope and type.

1.04 PERFORMANCE REQUIREMENTS

A. The manufacturer shall be responsible for the configuration and fabrication of the complete unitized panel system.
1. When requested, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Standard panel system shall have less than 0.01 cfm/ft² air leakage by ASTM E 283 at 6.24 PSF (50 mph) and no water penetration by ASTM E 331 at 15 PSF; and structural testing by ASTM E 330.
3. Structural Loads; Provide system capable of handling the following loads:
a. Wind Loads: Refer to Section 01 73 24.
b. Seismic Performance: Fiberglass wall panel systems withstand the effects of earthquake motions determined for component and cladding pressure according to ASCE/SEI 7.

B. Windborne Debris Impact Resistance Performance
   1. Translucent panels must be impact-resistant meeting the requirements of an approved impact-resisting standard: ASTM E 1996 and ASTM E 1886 or TAS 201, 202 and 203.
   2. Panel System designed to pass missile-impact and cyclic-pressure tests according to ASTM E 1996 for Wind Zone 1.

1.05 DELIVERY STORAGE AND HANDLING

A. Deliver panel system, components and materials in manufacturer's standard protective packaging.

B. Store panels on the long edge; several inches above the ground, blocked and under cover in accordance with manufacturer's storage and handling instructions.

1.06 WARRANTY

A. Submit manufacturer's and installer's written warranty agreeing to repair or replace panel system work, which fails in materials or workmanship within one year of the date of delivery. Failure of materials or workmanship shall include leakage, excessive deflection, deterioration of finish on metal in excess of normal weathering, defects in accessories, insulated translucent sandwich panels and other components of the work.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. The basis for this specification is for products manufactured by Kalwall Corporation. Other manufacturers may bid this project provided they comply with all of the performance requirements of this specification and submit evidence thereof. Listing other manufacturers' names in this specification does not constitute approval of their products or relieve them of compliance with all the performance requirements contained herein.

B. Kalwall Corporation, Tel: (800) 258-9777 – Fax: (603) 627-7905 – Email: info@kalwall.com

2.02 PANEL COMPONENTS

A. Face Sheets
   1. Translucent faces: Manufactured from glass fiber reinforced thermoset resins, formulated specifically for architectural use.
      a. Thermoplastic (e.g. polycarbonate, acrylic) faces are not acceptable.
      b. Face sheets shall not deform, deflect or drip when subjected to fire or flame.
   2. Interior face sheets:
      a. Flame spread: Underwriters Laboratories (UL) listed, which requires periodic unannounced retesting, with flame spread rating no greater than 25 and smoke developed no greater than 250 when tested in accordance with UL 723.
      b. Burn extent by ASTM D 635 shall be no greater than 1".

3. Exterior face sheets:
    a. Color stability: Full thickness of the exterior face sheet shall not change color more than 3 CIE Units DELTA E by ASTM D 2244 after 5 years outdoor South Florida weathering at 5° facing south, determined by the average of at least three white samples with and without a protective film or coating to ensure long-term color stability. Color stability shall be unaffected by abrasion or scratching.
    b. Strength: Exterior face sheet shall be uniform in strength, with panel meeting ASTM E1996 and ASTM E1886 or TAS 201, 202 and 203.
4. Appearance
    a. Exterior face sheets: Smooth 0.070" thick and Crystal in color.
    b. Interior face sheets: Smooth 0.045" thick and Crystal in color.
    c. Face sheets shall not vary more than ± 10% in thickness and be uniform in color.

B. Grid Core
1. Thermally Broken Composite I-beam grid core shall be of 6063-T6 or 6005-T5 alloy and temper with provisions for mechanical interlocking of muntin-mullion and perimeter. Width of I-beam shall be no less than 7/16".
2. I-beam Thermal break: Minimum 1", thermoset fiberglass composite.

C. Laminate Adhesive
1. Heat and pressure resin type adhesive engineered for structural sandwich panel use, with minimum 25-years field use. Adhesive shall pass testing requirements specified by the International Code Council "Acceptance Criteria for Sandwich Panel Adhesives".
2. Minimum tensile strength of 750 PSI when the panel assembly is tested by ASTM C 297 after two exposures to six cycles each of the aging conditions prescribed by ASTM D 1037.
3. Minimum shear strength of the panel adhesive by ASTM D 1002 after exposure to four separate conditions:
    a. 50% Relative Humidity at 68° F: 540 PSI
    b. 182° F: 100 PSI
    c. Accelerated Aging by ASTM D 1037 at room temperature: 800 PSI
    d. Accelerated Aging by ASTM D 1037 at 182° F: 250 PSI

2.03 PANEL CONSTRUCTION

A. Provide sandwich panels of flat fiberglass reinforced translucent face sheets laminated to a grid core of mechanically interlocking I-beams. The adhesive bonding line shall be straight, cover the entire width of the I-beam and have a neat, sharp edge.
1. Thickness: 2-3/4"
2. Light transmission: 10%
3. Solar heat gain coefficient 0.13.
4. Panel U-factor by NFRC certified laboratory: 2-3/4" thermally broken grid 0.10 U-factor.
5. Grid pattern: Nominal size 8" x 20"; pattern Shoji.

B. Standard panels shall deflect no more than 1.9” at 30 PSF in 10’ 0” span without a supporting frame by ASTM E 72.

C. Standard panels shall withstand 1200° F fire for minimum one hour without collapse or exterior flaming.

D. Thermally broken panels: Minimum Condensation Resistance Factor of 80 by AAMA 1503 measured on the bond line.
   1. Manufacturer's factory applied finish, which meets the performance requirements of AAMA 2604. Color to be selected from manufacturer's standards.

E. Finish is to be coordinated with closure system.

PART 3 EXECUTION

3.01 EXAMINATION

A. Installer shall examine substrates, supporting structure and installation conditions.

B. Do not proceed with panel installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Metal Protection
   1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
   2. Where aluminum will contact concrete, masonry or pressure treated wood, protect against corrosion by painting contact surfaces with bituminous paint or method recommended by manufacturer.

3.03 INSTALLATION

A. Install the panel system in accordance with the manufacturer's suggested installation recommendations and approved shop drawings.
   1. Anchor component parts securely in place by permanent mechanical attachment system.
   2. Accommodate thermal and mechanical movements.
   3. Set perimeter framing in a full bed of sealant compound, or with joint fillers or gaskets to provide weather-tight construction

B. Install joint sealants at perimeter joints and within the panel system in accordance with manufacturer's installation instructions.

3.04 CLEANING

A. Clean the panel system interior and exterior, immediately after installation.

B. Refer to manufacturer's written recommendations.

END OF SECTION

SECTION 08 51 13

ALUMINUM WINDOWS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes aluminum windows for exterior and interior locations.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.

C. Samples: For each exposed product and for each color specified.

1.03 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Sample warranties.

1.04 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.
   1. Warranty Period:
      a. Window: 10 years from date of Substantial Completion.
      b. Glazing Units: 10 years from date of Substantial Completion.
      c. Aluminum Finish: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 WINDOW PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
   1. Window Certification: AAMA certified with label attached to each window.

B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:
   1. Minimum Performance Class: CW.
   2. Minimum Performance Grade: 30.

C. Thermal Transmittance: NFRC 100 maximum whole-window U-factor of 0.45 Btu/sq. ft. x h x deg F.

D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum whole-window SHGC of 0.38.

E. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a CRF of 45.

F. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change: 120 deg F ambient; 180 deg F material surfaces.

2.02 ALUMINUM WINDOWS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Custom Window Company.
   2. EFCO Corporation.
   3. Manko Window Systems, Inc.
   4. TRACO.
   5. Wausau Window and Wall Systems; Apogee Wausau Group, Inc.
   6. Winco Window Company.
   7. YKK AP America Inc.

B. Types: As indicated on Drawings.

C. Frames: Aluminum extrusions complying with AAMA/WDMA/CSA 101/I.S.2/A440.
   1. Thermally Improved Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.

D. Insulating-Glass Units: ASTM E2190.

E. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal.

F. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.
   1. Exposed Fasteners: Do not use exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

2.03 FABRICATION

A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.

B. Glaze aluminum windows in the factory.

C. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.

D. Provide water-shed members above side-hinged sashes and similar lines of natural water penetration.

E. Mullions: Provide mullions and cover plates, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections. Provide mullions and cover plates capable of withstanding design wind loads of window units.

F. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

2.04 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

1. Color: As selected by Architect from full range of industry colors and color densities.

PART 3 EXECUTION

3.01 INSTALLATION

A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.

B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.

C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

D. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

E. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

F. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

END OF SECTION

SECTION 08 71 00

DOOR HARDWARE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hardware for hollow metal doors.

B. Electrically operated and controlled hardware.

C. Lock cylinders for doors with balance of hardware specified in other sections.

D. Thresholds.

E. Weatherstripping and gasketing.

1.02 RELATED REQUIREMENTS

A. Section 08 11 13 - Hollow Metal Doors and Frames.

B. Section 08 33 23 – Overhead Coiling Doors

1.03 REFERENCE STANDARDS

A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.

B. BHMA A156.1 - Standard for Butts and Hinges 2021.

C. BHMA A156.3 - Exit Devices 2020.

D. BHMA A156.4 - Door Controls - Closers 2019.

E. BHMA A156.5 - Cylinders and Input Devices for Locks 2020.

F. BHMA A156.7 - Template Hinge Dimensions 2016.

G. BHMA A156.13 - Mortise Locks & Latches Series 1000 2017.

H. BHMA A156.16 - Auxiliary Hardware 2018.

I. BHMA A156.18 - Materials and Finishes 2020.

J. BHMA A156.21 - Thresholds 2019.

K. BHMA A156.22 - Standard for Gasketing 2021.

L. BHMA A156.28 - Recommended Practices For Mechanical Keying Systems 2018.

M. BHMA A156.115 - Hardware Preparation In Steel Doors And Steel Frames 2016.

N. DHI (H&S) - Sequence and Format for the Hardware Schedule 2019.

O. DHI (KSN) - Keying Systems and Nomenclature 2019.

P. DHI (LOCS) - Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames 2004.

Q. ICC (IBC) - International Building Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

R. ICC A117.1 - Accessible and Usable Buildings and Facilities 2017.

S. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

T. NFPA 101 - Life Safety Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

U. UL (DIR) - Online Certifications Directory Current Edition.

V. UL 294 - Access Control System Units Current Edition, Including All Revisions.

W. UL 1784 - Standard for Air Leakage Tests of Door Assemblies Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the manufacture, fabrication, and installation of products that door hardware is installed on.

B. Sequence installation to ensure facility services connections are achieved in an orderly and expeditious manner.

C. Preinstallation Meeting: Convene a preinstallation meeting one week prior to commencing work of this section; require attendance by affected installers and the following:
   1. Installer's Architectural Hardware Consultant (AHC).
   2. Hardware Installer.
   3. Owner's Security Consultant.

D. Furnish templates for door and frame preparation to manufacturers and fabricators of products requiring internal reinforcement for door hardware.

E. Keying Requirements Meeting:
   1. Attendance Required:
      a. Contractor.
      b. Owner.
      c. Installer's Architectural Hardware Consultant (AHC).
      d. Owner's Security Consultant.

2. Agenda:
    a. Establish keying requirements.
    b. Verify locksets and locking hardware are functionally correct for project requirements.
    c. Verify that keying and programming complies with project requirements.
    d. Establish keying submittal schedule and update requirements.
3. Incorporate "Keying Requirements Meeting" decisions into keying submittal upon review of door hardware keying system including, but not limited to, the following:
    a. Access control requirements.
    b. Key control system requirements.
    c. Schematic diagram of preliminary key system.
4. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.
5. Deliver established keying requirements to manufacturers.

1.05 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures.

B. Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this project, and includes construction details, material descriptions, finishes, and dimensions and profiles of individual components.

C. Shop Drawings - Door Hardware Schedule: A detailed listing that includes each item of hardware to be installed on each door.
1. Prepared by or under supervision of Architectural Hardware Consultant (AHC).
2. Comply with DHI (H&S) using door numbering scheme and hardware set numbers as indicated in Contract Documents.
    a. Submit in vertical format.
3. Include complete description for each door listed.
4. Include manufacturer's and product names, and catalog numbers; include functions, types, styles, sizes and finishes of each item.
5. Include account of abbreviations and symbols used in schedule.

D. Shop Drawings - Electrified Door Hardware: Include diagrams for power, signal, and control wiring for electrified door hardware that include details of interface with building safety and security systems. Provide elevations and diagrams for each electrified door opening as follows:
1. Prepared by or under supervision of Architectural Hardware Consultant (AHC) and Electrified Hardware Consultant (EHC).
2. Elevations: Include front and back elevations of each door opening showing electrified devices with connections installed and an operations narrative describing how opening operates from either side at any given time.
3. Diagrams: Include point-to-point wiring diagrams that show each device in door opening system with related colored wire connections to each device.

E. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

F. Manufacturer's qualification statement.

G. Installer's qualification statement.

H. Supplier's qualification statement.

I. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
   1. Include manufacturer's parts lists.

J. Keying Schedule:
   1. Submit three (3) copies of Keying Schedule in compliance with requirements established during Keying Requirements Meeting unless otherwise indicated.

K. Warranty: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

L. Project Record Documents: Record actual locations of concealed equipment, services, and conduit.

M. Maintenance Materials and Tools: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 66 00 - Product Storage and Handling Requirements, for additional provisions.
   2. Tools: One set of each special wrench or tool applicable for each different or special hardware component, whether supplied by hardware component manufacturer or not.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified for commercial door hardware with at least five years of documented experience.

C. Supplier Qualifications: Company with certified Architectural Hardware Consultant (AHC) to assist in work of this section.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Package hardware items individually; label and identify each package with door opening code to match door hardware schedule.

1.08 WARRANTY

A. Manufacturer Warranty: Provide manufacturer warranty against defects in material and workmanship for period indicated, from Date of Substantial Completion. Complete forms in Owner's name and register with manufacturer.
   1. Closers: Twenty five years, minimum.
   2. Exit Devices: One year, minimum.
   3. Locksets and Cylinders: Five years, minimum.

PART 2 PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Provide specified door hardware as required to make doors fully functional, compliant with applicable codes, and secure to extent indicated.

B. Provide individual items of single type, of same model, and by same manufacturer.

C. Locks: Provide a lock for each door, unless it's indicated that lock is not required.
   1. Lock Function: Provide lock and latch function numbers and descriptions of manufacturer's Series. As indicated in hardware sets.
   2. Trim: Provide lever handle or pull trim on outside of each lock, unless otherwise indicated.
   3. Strikes:
      a. Finish: To match lock or latch.
      b. Curved-Lip Strikes: Provide as standard, with extended lip to protect frame, unless otherwise indicated.
      c. Center Strike At Pairs of Doors: 7/8 inch (22.2 mm) lip.

D. Closers:
   1. Provide door closer on each exterior door, unless otherwise indicated.
   2. Provide door closer on each fire-rated and smoke-rated door.
   3. Spring hinges are not an acceptable self-closing device, unless otherwise indicated.

E. Drip Guards: Provide at head of outswinging exterior doors unless protected by roof or canopy directly overhead.

F. Thresholds:
   1. Exterior Applications: Provide at each exterior door, unless otherwise indicated.

G. Weatherstripping and Gasketing:
   1. Provide weatherstripping on each exterior door at head, jambs, and meeting stiles of door pairs, unless otherwise indicated.
   2. Provide door bottom sweep on each exterior door, unless otherwise indicated.
   3. Fabricate as continuous gasketing, do not cut or notch gasketing material.

H. Electrically Operated and/or Controlled Hardware: Provide necessary power supplies, power transfer hinges, relays, and interfaces as required for proper operation; provide wiring between hardware and control components and to building power connection in compliance with NFPA 70.

I. Fasteners:
   1. Provide fasteners of proper type, size, quantity, and finish that comply with commercially recognized standards for proposed applications.
      a. Aluminum fasteners are not permitted.
      b. Provide phillips flat-head screws with heads finished to match door surface hardware unless otherwise indicated.
   2. Provide machine screws for attachment to reinforced hollow metal and aluminum frames.
      a. Self-drilling (Tek) type screws are not permitted.
   3. Provide stainless steel machine screws and lead expansion shields for concrete and masonry substrates.
   4. Provide wall grip inserts for hollow wall construction.
   5. Fire-Resistance-Rated Applications: Comply with NFPA 80.
      a. Provide wood or machine screws for hinges mortised to doors or frames, strike plates to frames, and closers to doors and frames.
      b. Provide steel through bolts for attachment of surface mounted closers, hinges, or exit devices to door panels unless proper door blocking is provided.
   6. Concealed Fasteners: Do not use through or sex bolt type fasteners on door panel sides indicated as concealed fastener locations, unless otherwise indicated or required per manufacturer's testing requirements.

2.02 PERFORMANCE REQUIREMENTS

A. Provide door hardware products that comply with the following requirements:
   1. Applicable provisions of federal, state, and local codes.
      a. ICC (IBC).
      b. NFPA 101.
   2. Accessibility: ADA Standards and ICC A117.1.
   3. Hardware Preparation for Steel Doors and Steel Frames: BHMA A156.115.
   4. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified.

2.03 HINGES

A. Manufacturers: Conventional butt hinges.
   1. BEST; dormakaba Group: www.bestaccess.com/#sle.

B. Properties:
   1. Butt Hinges: As applicable to each item specified.
      a. Standard Weight Hinges: Minimum of two (2) permanently lubricated non-detachable bearings.

b. Heavy Weight Hinges: Minimum of four (4) permanently lubricated bearings on heavy weight hinges.
c. Template screw hole locations.
d. Bearing assembly installed after plating.
e. Bearings: Exposed fully hardened bearings.
f. Bearing Shells: Shapes consistent with barrels.
g. Pins: Easily seated, non-rising pins.
    1) Fully plate hinge pins.
    2) Non-Removable Pins: Slotted stainless steel screws.
h. UL 10C listed for fire-resistance-rated doors.

C. Sizes: See Door Hardware Schedule.
1. Hinge Widths: As required to clear surrounding trim.
2. Sufficient size to allow 180 degree swing of door.

D. Finishes: See Door Hardware Schedule.
1. Fully polish hinges; front, back, and barrel.

E. Grades:
1. Butt Hinges: Comply with BHMA A156.1 and BHMA A156.7 for templated hinges.
2. Comply with BHMA A156.18 Materials and Finishes.

F. Material: Base metal as indicated for each item by BHMA material and finish designation.

G. Types:
1. Butt Hinges: Include full mortise hinges.

H. Options: As applicable to each item specified.

I. Quantities:
1. Butt Hinges: Three (3) hinges per leaves up to 90 inches (2286 mm) in height. Add one (1) for each additional 30 inches (762 mm) in height or fraction thereof.
    a. Hinge weight and size unless otherwise indicated in hardware sets:
        1) For doors up to 36 inches (914 mm) wide and up to 1-3/4 inches (44.5 mm) thick provide hinges with a minimum thickness of 0.134 inch (3.4 mm) and a minimum of 4-1/2 inches (114 mm) in height.
        2) For doors from 36 inches (914 mm) wide up to 42 inches (1067 mm) wide and up to 1-3/4 inches (44.5 mm) thick provide hinges with a minimum thickness of 0.145 inch (3.7 mm) and a minimum of 4-1/2 inches (114 mm) in height.
        3) For doors from 42 inches (1067 mm) wide up to 48 inches (1219 mm) wide and up to 1-3/4 inches (44.5 mm) thick provide hinges with a minimum thickness of 0.180 inch (4.6 mm) and a minimum of 5 inches (127 mm) in height.

4) For doors greater than 1-3/4 inches (44.5 mm) thick provide hinges with a minimum thickness of 0.180 inch (4.6 mm) and a minimum of 5 inches (127 mm) in height.

J. Applications: At swinging doors.
   1. Provide non-removable pins at out-swinging doors with locking hardware and all exterior doors.

K. Products:
   1. Butt Hinges:
      a. Ball Bearing, Five (5) Knuckle.

2.04 BOLTS

A. Manufacturers:
   1. Trimco: www.trimcohardware.com/#sle.

B. Properties:
   1. Flush Bolts:
      a. Pairs of Swing Doors: At inactive leaves, provide flush bolts of type as required to comply with code.
      b. Automatic Flush Bolts: Automatically latching upon closing of door leaf.
         1) Bolt Throw: 3/4 inch (19 mm), minimum.
   2. Dustproof Strikes: For bolting into floor, provide except at metal thresholds.

C. Options:
   1. Lever extensions: Provide for top bolt at oversized doors.

D. Products:
   1. Automatic flush bolts.

2.05 EXIT DEVICES

A. Manufacturers:
   1. BEST, dormakaba Group: www.bestaccess.com/#sle.

B. Properties:
   1. Actuation: Full-length touchpad.
   2. Chassis:
      a. Construction: Investment cast steel, zinc dichromate plated.
      b. Compatibility: Standard Stile doors.
   3. Touchpads: 'T" style metal touchpads and rail assemblies with matching chassis covers end caps.
   4. Latch Bolts: Stainless steel deadlocking with 3/4 inch (19 mm) projection using latch bolt.
   5. Lever Design: Match project standard lockset trims.
   6. Cylinder: Include where cylinder dogging or locking trim is indicated.

7. Strike as recommended by manufacturer for application indicated.
8. Sound dampening on touch bar.
9. Dogging:
    a. Non-Fire-Resistance-Rated Devices: Cylinder 1/4 inch (6 mm) hex key dogging.
    b. Touch bar assembly on wide style exit devices to have a 1/4 inch (6.3 mm) clearance to allow for vision frames.
10. All exposed exit device components to be of architectural metals and “true” architectural finishes.
11. Handing: Field-reversible.
12. Fasteners on Back Side of Device Channel: Concealed - exposed fasteners not allowed.
13. Vertical Latch Assemblies' Operation: Gravity, without use of springs.
    a. Latch Bolts: Stainless steel, with 1/2 inch (12.7 mm) throw.

C. Grades: Complying with BHMA A156.3, Grade 1.
1. Provide exit devices tested and certified by UL or by a recognized independent laboratory for mechanical operational testing to 10 million cycles minimum with inspection confirming Grade 1 Loaded Forces have been maintained.

D. Code Compliance: As required by authorities having jurisdiction in the State in which the Project is located.

E. Options:
1. Internally mounted switch used to signal other components.
2. MLR: Motorized latch retraction.
3. Electrified Device Voltage: 24 VDC.

F. Products:
1. 2000.

2.06 LOCK CYLINDERS

A. Manufacturers:
1. BEST, dormakaba Group: www.bestaccess.com/#sle.

B. Properties:
1. Lock Cylinders: Provide key access on outside of each lock, unless otherwise indicated.
    a. Provide cylinders from same manufacturer as locking device.
    b. Provide cams and/or tailpieces as required for locking devices.
    c. Provide cylinders with appropriate format interchangeable cores where indicated.

C. Grades:
1. Standard Security Cylinders: Comply with BHMA A156.5.

D. Types: As applicable to each item specified.

1. Standard security small format interchangeable core (SFIC) type cylinders, with seven-pin, 1C - 7-pin cores.

E. Applications: At locations indicated in hardware sets.

F. Products:
1. Rim/mortise.

2.07 MORTISE LOCKS

A. Manufacturers:
1. BEST, dormakaba Group: www.bestaccess.com/#sle.

B. Properties:
1. Mechanical Locks: Manufacturer's standard.
a. Fitting modified ANSI A115.1 door preparation.
b. Door Thickness Coordination Fitting 1-3/4 inch (44 mm) to 2-1/4 inch (57 mm) thick doors.
c. Latch: Solid, one-piece, anti-friction, self-lubricating stainless steel.
1) Latchbolt Throw: 3/4 inch (19 mm), minimum.
d. Auxiliary Deadlatch: One piece stainless steel, permanently lubricated.
e. Backset: 2-3/4 inch (70 mm).
f. Cylinders:
1) Cylinder Security: Use concealed internal setscrew accessible only by removing the core with the control key from the cylinder body for securing the cylinder to the lockset.
2) Cylinder Core Types: Locks capable of supporting manufacturers' cores, as applicable.
a) 7-pin, removable.
b) Small format interchangeable.
g. Lever Trim:
1) Functionality: Allow the lever handle to move up to 45 degrees from horizontal position prior to engaging the latchbolt assembly.
2) Strength: Locksets outside locked lever designed to withstand minimum 1,400 inch-lbs (158.2 Nm) of torque. In excess of that, a replaceable part will shear. Key from outside and/or inside lever will still operate lockset.
3) Spindle: Designed to prevent forced entry from attacking of lever.
4) Independent spring mechanism for each lever.
a) Trim to be self-aligning and thru-bolted.
5) Handles: Made of forged or cast brass, bronze, or stainless steel construction. Levers that contain a hollow cavity are not acceptable.
6) Levers to operate a roller bearing spindle hub mechanism.
2. Electrified Locks: Same properties as standard locks, and as follows:
a. Voltage: 24 VDC.
b. Function: Electrically locked (Fail Safe) or unlocked (Fail Secure), as indicated for each lock in Door Hardware Schedule.

c. Internal request-to-exit feature.

C. Finishes: See Door Hardware Schedule.
1. Core Faces: Match finish of lockset.

D. Grades:
1. Comply with BHMA A156.13, Grade 1, Security; Grade 2.

E. Options:
1. Provide locksets made in a manufacturing facility to compliant with ISO 9001-Quality Management and ISO 14001-Environmental Management.

F. Products: Mortise locks, including standard and electrified types.
1. 40H.

2.08 COORDINATORS

A. Manufacturers:
1. Trimco: www.trimcohardware.com/#sle.

B. Properties:
1. General: Non-handed devices, with field-selectable active door leaf.
2. Coordinators: Devices on pairs of doors with closers and self-latching or automatic flush bolts installed.
a. Coordinator Operation: Only when inactive door is opened.

C. Grades:
1. Closer and Coordinator Combinations: Comply with BHMA A156.4, Grade 1.

D. Code Compliance: As required by authorities having jurisdiction in the State in which the Project is located.
1. Meet UL 10C for Positive Pressure.

E. Types:
1. Coordinators: Bar.

F. Installation:
1. Mounting: Provide necessary mounting brackets and filler bars to ensure proper installation of coordinator and related hardware.
2. Coordination: Properly sequence installation of other door hardware affected by placement of coordinators and carry bars.

G. Products:
1. 3090 Series.

2.09 CARRY BARS

A. Manufacturers:

1. Trimco: www.trimcohardware.com/#sle.

B. Material: Brass with nylon rollers, unless otherwise indicated.

C. Products:
   1. 3090 Carry Open Bar Assembly.

2.10 CLOSERS

A. Manufacturers:
   1. dormakaba; dormakaba Group: www.dormakaba.com/us-en/#sle.

B. Properties:
   1. Surface Mounted Closers: Manufacturer's standard.
      a. Construction: R14 high silicon aluminum alloy.
      b. Maximum Projection from Face of Door: 2-1/8 inches (54 mm).
      c. Mechanism: Separate tamper-resistant adjusting valves for closing and latching speeds.
      d. Hydraulic Fluid: All-weather type.
      e. Arm Assembly: Standard for product specified.
         1) Material: Steel.
         2) Include hold-open or spring-loaded stop feature, as specified in Door Hardware Schedule.
         3) Parallel arm to be a heavy-duty rigid arm.
      f. Covers:
         1) Type: Standard for product selected.
            a) Full.
         2) Material: Plastic.
         3) Finish: Painted.

C. Grades:
   1. Closers: Comply with BHMA A156.4, Grade 1.
      a. Underwriters Laboratories Compliance:
         1) Product Listing: UL (DIR) and ULC for use on fire-resistance-rated doors.
            a) UL 228 - Door Closers-Holders, With or Without Integral Smoke Detectors.

D. Code Compliance: As required by authorities having jurisdiction in the State in which the Project is located.
   1. Devices listed with California Department of Forestry and Fire Protection, Office of the State Fire Marshal.

E. Types:
   1. Rack-and-pinion, surface-mounted. 1-1/2 inches (38 mm) minimum bore.

F. Installation:
   1. Mounting: Includes surface mounted installations.

2. Mount closers on non-public side of door and stair side of stair doors unless otherwise noted in hardware sets.
3. At outswinging exterior doors, mount closer on interior side of door.
4. Provide adapter plates, shim spacers, and blade stop spacers as required by frame and door conditions.
5. Where an overlapping astragal is included on pairs of swinging doors, provide coordinator to ensure door leaves close in proper order.

G. Products:
1. Surface Mounted:
a. 8900.

2.11 STOPS AND HOLDERS

A. Manufacturers:

B. General: Provide overhead stop/holder when wall or floor stop is not feasible.

C. Properties:
1. Wall Bumpers: 1270CX.

D. Grades:
1. Wall Bumpers: Comply with BHMA A156.16 and Resilient Material Retention Test as described in this standard.

E. Types:
1. Wall Bumpers: Bumper, convex, wall stop.

F. Installation:
1. Non-Masonry Walls: Confirm adequate wall reinforcement has been installed to allow lasting installation of wall bumpers.

2.12 THRESHOLDS

A. Manufacturers:
1. National Guard Products, Inc: www.ngpinc.com/#sle.

B. Properties:
1. Threshold Surface: Thermally broken.
a. Provide slip-resistance abrasive coating.

C. Grades: Thresholds: Comply with BHMA A156.21.

D. Material: Base metal as indicated for each item by BHMA material and finish designation.
1. Threshold Assemblies: Aluminum.

2.13 WEATHERSTRIPPING AND GASKETING

A. Manufacturers:
   1. National Guard Products, Inc: www.ngpinc.com/#sle.

B. Properties:
   1. Adhesive-Backed Perimeter Gasketing: Slilicone gasket material applied to frame with self- adhesive.
   2. Rigid, Housed, Perimeter Gasketing: Silicone bulb gasket material held in place by aluminum housing; fastened to frame stop with screws.
   3. Meeting Astragals for Meeting Stiles: Silicone bulb gasket material held in place by aluminum housing; mounted with screws.
      a. Mounting: Surface mounted on face of each door.
   4. Door Sweeps: Silicone gasket material held in place by flat aluminum housing or flange; surface mounted to face of door with screws.

C. Grades: Comply with BHMA A156.22.

D. Products:
   1. Weatherstripping: See Door Hardware Schedule.
   2. Meeting Stile Seals: See Door Hardware Schedule.
   3. Door Bottom Seals:
      a. Door Sweeps: See Door Hardware Schedule.

2.14 MISCELLANEOUS ITEMS

A. Manufacturers:
   1. BEST, dormakaba Group: www.bestaccess.com/#sle.
   2. Trimco: www.trimcohardware.com/#sle.

B. Properties:
   1. Latch Protectors: Provide on door to protect latch from being tampered with while in locked position.
      a. Type: Standard latch protector.
      b. Material: Stainless steel.
   2. Silencers: Provide at equal locations on door frame to mute sound of door's impact upon closing.
      a. Single Door: Provide three on strike jamb of frame.
      b. Pair of Doors: Provide two on head of frame, one for each door at latch side.
      c. Material: Rubber, gray color.

C. Products:
   1. Latch Protectors.
      a. 5000 Series.

2.15 ELECTRIFIED HARDWARE

A. Manufacturers:
   1. BEST, dormakaba Group: www.bestaccess.com/#sle.
   2. RCI; dormakaba Group: www.dormakaba.com/us-en/#sle.
   3. Interlogix United Technologies.

B. Properties:
   1. Door Position Switches: Recessed devices with magnetic contacts.
      a. Power Requirement: 25mA Max, 30VAC/DC.
   2. Power Supply Units: Manufacturer's standard.
      a. Regulatory Compliance:
         1) United States Compliance:
            a) UL listed for Class II Output.
            b) Comply with UL 294 Standards incorporating enhanced Access Control. communications capabilities.
      b. Enclosures: Lockable NEMA Type 1, with hinged cover and knockouts.
      c. Power: 24 VDC, 2 Amp.
         1) Incoming Power Voltage: 120 VAC.
      d. Capable of incorporating up to two (2) control modules, one per each controlled device.
      e. Output Distribution Board with indicator LEDs.
      f. On/Off LED power indicator.
   3. Power Transfers: Manufacturer's standard.
      a. Mortised Type with Wires & Connectors:
         1) Listed by UL and ULC.
         2) Stainless steel housing and spring conduit.
         3) Wire Harness: Pre-installed, twelve wire, equipped with ten (10) 24 gauge wires and two 18 gauge wires.
         4) Accommodate 180 degree door swing.
         5) Quick-Connect Plugs: Pre-installed.
   4. Wire Harnesses: Of sufficient length, with quick connectors.
      a. Wire Harness End Connection to Power Supply or Junction Box: One end with bare leads.

C. Products:
   1. Door Position Switches:
      a. 9540 Recessed Magnetic Contact/Door Position Switch.
   2. Power Supplies:
      a. RPSMLR2.
   3. Power Transfers:
      a. EPT-12C.
   4. Wire Harnesses:
      a. BEST wire harnesses.

2.16 KEYS AND CORES

A. Manufacturers:
   1. BEST, dormakaba Group: www.bestaccess.com/#sle.

B. Properties: Complying with guidelines of BHMA A156.28.
   1. Provide small format interchangeable core.
   2. Provide Patented CORMAX keys and cores.
   3. Provide keying information in compliance with DHI (KSN) standards.
   4. Keying Schedule: Arrange for a keying meeting, with Architect, Owner and hardware supplier, and other involved parties to ensure locksets and locking hardware, are functionally correct and keying complies with project requirements.
   5. Keying: Master keyed.
   6. Include construction keying and control keying with removable core cylinders.
   7. Supply keys in following quantities:
      a. Master Keys: 4 each.
      b. Construction Keys: 15 each.
      c. Construction Control Keys: 2 each.
      d. Control Keys if New System: 2 each.
   8. Provide key collection envelopes, receipt cards, and index cards in quantity suitable to manage number of keys.
   9. Deliver keys with identifying tags to Owner by security shipment direct from manufacturer.
   10. Permanent Keys and Cores: Stamped with applicable key marking for identification. Do not include actual key cuts within visual key control marks or codes. Stamp permanent keys "Do Not Duplicate."
   11. Include installation of permanent cores and return construction cores to hardware supplier. Construction cores and keys to remain property of hardware supplier.

C. Products:
   1. Patented:
      a. CORMAX.

2.17 FINISHES

A. Finishes: Identified in Hardware Sets.

PART 3 PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that doors and frames are ready to receive this work; labeled, fire-rated doors and frames are properly installed, and dimensions are as indicated on shop drawings.

B. Correct all defects prior to proceeding with installation.

C. Verify that electric power is available to power operated devices and of correct characteristics.

3.02 INSTALLATION

A. Install hardware in accordance with manufacturer's instructions and applicable codes.

B. Install hardware using the manufacturer's fasteners provided. Drill and tap all screw holes located in metallic materials. Do not use "Riv-Nuts" or similar products.

C. Use templates provided by hardware item manufacturer.

D. Do not install surface mounted items until application of finishes to substrate are fully completed.

E. Wash down masonry walls and complete painting or staining of doors and frames.

F. Complete finish flooring prior to installation of thresholds.

G. Door Hardware Mounting Heights: Distance from finished floor to center line of hardware item. As indicated in following list; unless noted otherwise in Door Hardware Schedule or on drawings.
   1. For Steel Doors and Frames: Install in compliance with DHI (LOCS) recommendations.
   2. For Steel Doors and Frames: See Section 08 11 13.
   3. Mounting heights in compliance with ADA Standards:
      a. Locksets: 40-5/16 inch (1024 mm).
      b. Push Plates/Pull Bars: 42 inch (1067 mm).
      c. Deadlocks (Deadbolts): 48 inch (1219 mm).
      d. Exit Devices: 40-5/16 inch (1024 mm).
      e. Door Viewer: 43 inch (1092 mm); standard height 60 inch (1524 mm).

H. Set exterior door thresholds with full-width bead of elastomeric sealant at each point of contact with floor providing a continuous weather seal; anchor thresholds with stainless steel countersunk screws.

I. Include in installation for existing doors and frames any necessary field modification and field preparation of doors and frames for new hardware. Provide necessary fillers, reinforcements, and fasteners for mounting new hardware and to cover existing door and frame preparations.

3.03 FIELD QUALITY CONTROL

A. Perform field inspection and testing under provisions of Section 01 45 00 – Contractor Quality Control.

3.04 ADJUSTING

A. Adjust work under provisions of Section 01 79 00 – Demonstration and Training.

B. Adjust hardware for smooth operation.

C. Adjust gasketing for complete, continuous seal; replace if unable to make complete seal.

3.05 CLEANING

A. Clean finished hardware in accordance with manufacturer's written instructions after final adjustments have been made.

B. Clean adjacent surfaces soiled by hardware installation activities.

C. Replace items that cannot be cleaned to manufacturer's level of finish quality at no additional cost.

3.06 PROTECTION

A. Protect finished Work under provisions of Section 01 79 00 – Demonstration and Training Requirements.

B. Do not permit adjacent work to damage hardware or finish.

3.07 HARDWARE SCHEDULE

Manufacturer List

Code	Name
AB	ABH Manufacturing Inc.
BE	Best Access Systems
BY	By Security Provider
DM	Dorma Door Controls
NA	National Guard
PR	BEST Precision Exit Devices
SENT	Interlogix United Technologies
ST	BEST Hinges and Sliding
TR	Trimco

Option List

Code	Description
10-24 SSMS/LA	STAINLESS MACHINE SCREWS/LEAD ANCHOR
48"	48" Door Width
C	Quick Connect Wiring System
FMC	Full Metal Cover
RQE	REQUEST TO EXIT
S301	OPT. ROLLER. STRK - RIM AND TOP OF SVR
SIA	ABRASIVE COATING-5" WIDTH-AL OR SS
TS	TOUCHBAR MONITORING SWITCH

Finish List

Code	Description
32D	Satin Stainless Steel
626	Satin Chromium Plated
630	Satin Stainless Steel
689	Aluminum Painted

AL	Aluminum
D	Bronze Anodized Aluminum
GREY	Grey
US28	Aluminum - Clear Anodized

Hardware Sets

Set #1

3	Butt Hinge	FBB199 4.5" x 4.5" NRP	32D	ST
1	Electromechanical Lock	45HW-7DEU15N PATD C RQE	630	BE
1	Closer - S/Stop	8916 S-DS FMC	689	DM
1	Lock Astragal	5001	630	TR
1	Drip Cap	16 A - 4" ODW		NA
1	Weatherstrip	700 SA (Head & Jambs)		NA
1	Door Sweep	200 NA		NA
1	Threshold - Thermal Break	8425 SSMS/LA SIA LAR	AL	NA
1	Power Transfer	EPT-12C		PR
1	Door Contact	1076	D	SENT
1	Power Supply	RPSMLR2		PR
1	Harness	WH-192		ST
1	Harness	WH-6E		ST
1	Harness	WH-LAR		ST
1	Card Reader	By security provider		BY

Set #2

3	Butt Hinge	FBB199 4.5" x 4.5" NRP	32D	ST
1	Exit Device	C MLR TS 2103 X 1703A	630	PR
1	Rim Cylinder	12E-72 PATD	626	BE
1	Closer - S/Stop	8916 S-DS FMC	689	DM
1	Drip Cap	16 A - 4" ODW		NA
1	Weatherstrip	700 SA (Head & Jambs)		NA
1	Door Sweep	200 NA		NA
1	Threshold – Thermal Break	8425 SSMS/LA SIA LAR	AL	NA
1	Power Transfer	EPT-12C		PR
1	Door Contact	1076	D	SENT
1	Power Supply	RPSMLR2		PR
1	Harness	WH-192		ST
1	Harness	WH-6E		ST
1	Harness	WH-LAR		ST
1	Card Reader	By security provider		BY

Set #4

6	Butt Hinge	FBB199 4.5" x 4.5" NRP	32D	ST
2	Manual Flushbolt	3917-12ET	626	TR
1	Dust Proof Strike	3910	630	TR
1	Electromechanical Lock	45HW-7DEU15N PATD C RQE	630	BE
1	Drip Cap	16 A - 4" ODW		NA
1	Weatherstrip	700 SA (Head & Jambs)		NA
1	Weatherstrip	5075 @ Door edge		NA
1	Astragal	139 SP LAR		NA
2	Door Sweep	200 NA		NA
1	Threshold – Thermal Break	8425 SSMS/LA SIA LAR	AL	NA
2	Closer - S/Stop	8916 S-DS FMC	689	DM
2	Power Transfer	EPT-12C		PR
2	Door Contact	1076	D	SENT
1	Power Supply	RPSMLR2		PR
1	Harness	WH-192		ST
1	Harness	WH-6E		ST
1	Harness	WH-LAR		ST
1	Card Reader	By security provider		BY

Set #5

6	Butt Hinge	FBB199 4.5" x 4.5" NRP	32D	ST
1	Exit Device - Night Latch	C TS 2203 X 1703A	630	PR
1	Exit Device - Exit Only	C TS 2801	630	PR
1	Mortise Cylinder	1E-74 PATD	626	BE
2	Closer - S/Stop	8916 S-DS FMC	689	DM
1	Drip Cap	16 A - 4" ODW		NA
1	Weatherstrip	700 SA (Head & Jambs)		NA
1	Coordinator	3700	US28	AB
2	Mounting Bracket	3751 / 3752	US28	AB
1	Carry Bar	3760	US28	AB
1	Weatherstrip	5075 @ Door edge		NA
1	Astragal	139 SP LAR		NA
2	Door Sweep	200 NA		NA
1	Threshold - Thermal Break	8425 SSMS/LA SIA LAR	AL	NA
1	Power Supply	RPSMLR2		PR
2	Power Transfer	EPT-12C		PR
2	Door Contact	1076	D	SENT
1	Harness	WH-192		ST
1	Harness	WH-6E		ST
1	Harness	WH-LAR		ST

Set #100

3	Butt Hinge	FBB191 4.5" x 4.5"	32D	ST
1	Privacy Set	45H-0LT15M	630	BE
1	Wall Bumper	1270CX	626	TR
1	Coat Hook	3071	626	TR
3	Silencer	1229A	GREY	TR

Set #101

3	Butt Hinge	FBB199 4.5" x 4.5" NRP	32D	ST
1	Exit Device	2103 X 4903A S301	630	PR
1	Rim Cylinder	12E-72 PATD	626	BE
1	Closer	8916 SPA FMC	689	DM
1	Wall Bumper	1270CX	626	TR
1	Gasketing	5040 B (Head & Jambs)		NA
1	Door Sweep	200 NA		NA
1	Saddle Threshold	425 E SSMS/LA LAR AL		NA

Set #102

3	Butt Hinge	FBB191 4.5" x 4.5"	32D	ST
1	Lockset	45H-7AT15N PATD	630	BE
1	Closer - HO	8916 PH FMC	689	DM
1	Wall Bumper	1270CX	626	TR
1	Gasketing	5040 B (Head & Jambs)		NA

Set #104

3	Butt Hinge	FBB191 4.5" x 4.5"	32D	ST
1	Passage Set	45H-0N15M	630	BE
1	Closer	8916 PH FMC	689	DM
1	Wall Bumper	1270CX	626	TR
1	Gasketing	5040 B (Head & Jambs)		NA
1	Door Sweep	200 NA		NA
1	Saddle Threshold	425 E SSMS/LA LAR AL		NA

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SECTION 08 80 00

GLAZING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Glass products.
   2. Insulating glass.
   3. Glazing tapes.
   4. Miscellaneous glazing materials.

1.02 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances to achieve proper safety margins for glazing retention under each design load case, load case combination, and service condition.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.

1.04 INFORMATIONAL SUBMITTALS

A. Product Certificates: For glass.

B. Product test reports.

C. Preconstruction adhesion and compatibility test report.

D. Sample warranties.

1.05 QUALITY ASSURANCE

A. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

1.06 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
   1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is obstruction of vision by dust, moisture, or film on interior surfaces of glass.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined in accordance with the IBC and ASTM E1300:
   1. Design Wind Pressures: As indicated on Drawings.
   2. Design Snow Loads: As indicated on Drawings.
   3. Thermal Loads: Design glazing to resist thermal stress breakage induced by differential temperature conditions and limited air circulation within individual glass lites and insulated glazing units.

B. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
   1. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on most current non-beta version of LBL's WINDOW computer program, expressed as Btu/sq. ft. x h x deg F.
   2. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW computer program.
   3. Visible Reflectance: Center-of-glazing values, in accordance with NFRC 300.

2.02 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
   1. NGA Publications: "Glazing Manual."
   2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction or manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the IGCC.

D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than thickness indicated.

2.03 GLASS PRODUCTS

A. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

B. Reflective- and Low-E-Coated Vision Glass: ASTM C1376.

2.04 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.
   1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
   2. Perimeter Spacer: Manufacturer's standard spacer material and construction.
   3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.05 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:
   1. AAMA 804.3 tape, where indicated.
   2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
   3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
   1. AAMA 810.1, Type 1, for glazing applications in which tape acts as primary sealant.
   2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.06 MISCELLANEOUS GLAZING MATERIALS

A. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

B. Setting Blocks:
   1. EPDM with Shore A durometer hardness of 85, plus or minus 5.
   2. Type recommended in writing by sealant or glass manufacturer.

C. Spacers:
   1. Neoprene blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
   2. Type recommended in writing by sealant or glass manufacturer.

D. Edge Blocks:
   1. EPDM with Shore A durometer hardness per manufacturer's written instructions.
   2. Type recommended in writing by sealant or glass manufacturer.

E. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

PART 3 EXECUTION

3.01 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches.

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and in accordance with requirements in referenced glazing publications.

3.02 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Apply heel bead of elastomeric sealant.

F. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

G. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.03 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.04 CLEANING AND PROTECTION

A. Immediately after installation, remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
   1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

3.05 MONOLITHIC GLASS SCHEDULE: GL-1

A. Clear Glass Type: Fully tempered float glass.
   1. Minimum Thickness: 6 mm.
   2. Safety glazing required.

3.06 INSULATING GLASS SCHEDULE: GL-2

A. Low-E-Coated, Tinted Insulating Glass Type:
   1. Overall Unit Thickness: 1 inch.
   2. Minimum Thickness of Each Glass Lite: 6 mm.
   3. Outdoor Lite: Tinted fully tempered float glass.
   4. Tint Color: Blue-green.
   5. Interspace Content: Air.
   6. Indoor Lite: Clear fully tempered float glass.
   7. Low-E Coating: Pyrolytic on second surface.
   8. Safety glazing required.

END OF SECTION

SECTION 09 22 16

NON-STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Non-load-bearing steel framing systems for interior partitions.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of code-compliance certification for studs and tracks.

1.04 QUALITY ASSURANCE

A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association the Steel Framing Industry Association or the Steel Stud Manufacturers Association.

PART 2 PRODUCTS

2.01 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C754 for conditions indicated.
   1. Steel Sheet Components: Comply with ASTM C645 requirements for steel unless otherwise indicated.
   2. Protective Coating: ASTM A653/A653M, G60, hot-dip galvanized unless otherwise indicated.

B. Studs and Tracks: ASTM C645. Use either conventional steel studs and tracks or embossed, high-strength steel studs and tracks.
   1. Minimum Base-Steel Thickness: As required by performance requirements for horizontal deflection.
   2. Depth: As indicated on Drawings.

2.02 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.
   1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide one of the following:
   1. Asphalt-Saturated Organic Felt: ASTM D226/D226M, Type I (No. 15 asphalt felt), nonperforated.
   2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Installation Standard: ASTM C754.
   1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.02 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
   1. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

E. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

END OF SECTION

SECTION 09 29 00

GYPSUM BOARD

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Interior gypsum board.

1.02 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Gypsum board, Type X.
   2. Interior trim.
   3. Joint treatment materials.

B. Samples: For each texture finish indicated on same backing indicated for Work.

PART 2 PRODUCTS

2.01 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.02 INTERIOR GYPSUM BOARD

A. Gypsum Board, Type X: ASTM C1396/C1396M.
   1. Thickness: 5/8 inch.
   2. Long Edges: Tapered.

2.03 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047.
   1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
   2. Shapes:
      a. Cornerbead.
      b. Bullnose bead.
      c. Expansion (control) joint.

2.04 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M.

B. Joint Tape:
   1. Interior Gypsum Board: Paper.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
   1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
   2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
      a. Use setting-type compound for installing paper-faced metal trim accessories.
   3. Fill Coat: For second coat, use drying-type, all-purpose compound.
   4. Finish Coat: For third coat, use drying-type, all-purpose compound.

2.05 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
   1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
   2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION AND FINISHING OF PANELS

A. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

B. Comply with ASTM C840.

C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch-wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

D. For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

E. Prefill open joints and damaged surface areas.

F. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

G. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:
   1. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
      a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

3.02 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION

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SECTION 09 51 23

ACOUSTICAL TILE CEILINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Acoustical tiles for interior ceilings.
   2. Fully concealed, direct-hung, suspension systems.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

1.03 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, and coordinated with each other, using input from installers of the items involved.

B. Product test reports.

C. Research reports.

D. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance data.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: Class A according to ASTM E1264.
   2. Smoke-Developed Index: 50 or less.

2.02 ACOUSTICAL TILES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Armstrong World Industries, Inc.
   2. CertainTeed Corporation; Saint-Gobain North America.
   3. USG Corporation.

B. Acoustical Tile Standard: Manufacturer's standard tiles of configuration indicated that comply with ASTM E1264.

C. Classification: Type III, Form 2, Pattern CE.

D. Color: White.

E. Light Reflectance (LR): 0.85.

F. Noise Reduction Coefficient (NRC): 0.55.

G. Edge/Joint Detail: Square, kerfed, and rabbeted; tongue and grooved; or butt.

H. Thickness: 5/8 inch.

I. Modular Size: 24 by 24 inches.

2.03 METAL SUSPENSION SYSTEM

A. Metal Suspension-System Standard: Manufacturer's standard, direct-hung, fully concealed, metal suspension system that complies with applicable requirements in ASTM C635/C635M.

B. Direct-Hung, Double-Web Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation.
   1. Structural Classification: Intermediate-duty system.
   2. Access: Upward and end pivoted or side pivoted, with initial access openings of size indicated below and located throughout ceiling within each module formed by main and cross runners, with additional access available by progressively removing remaining acoustical tiles.
      a. Initial Access Opening: In each module, 24 by 24 inches.

2.04 ACCESSORIES

A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

2.05 METAL EDGE MOLDINGS AND TRIM

A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations complying with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for of suspension-system runners.

PART 3 EXECUTION

3.01 PREPARATION

A. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders unless otherwise indicated.

B. Layout openings for penetrations centered on the penetrating items.

3.02 INSTALLATION OF SUSPENDED ACOUSTICAL TILE CEILINGS

A. Install suspended acoustical tile ceilings according to ASTM C636/C636M and manufacturer's written instructions.

B. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical tiles.
   1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
   2. Do not use exposed fasteners, including pop rivets, on moldings and trim.

C. Arrange directionally patterned acoustical tiles as indicated on reflected ceiling plans.

END OF SECTION

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SECTION 09 65 00

RESILIENT BASE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Thermoset-rubber base.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

PART 2 PRODUCTS

2.01 THERMOSET-RUBBER BASE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Burke Mercer Flooring Products; a division of Burke Industries Inc.
   2. Flexco; Roppe Holding Company.
   3. Johnsonite; a Tarkett company.
   4. Roppe Corporation; Roppe Holding Company.

B. Product Standard: ASTM F1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).
   1. Style and Location:
      a. Style B, Cove.

C. Thickness: 0.125 inch.

D. Height: 4 inches.

E. Lengths: Coils in manufacturer's standard length.

F. Outside Corners: Preformed.

G. Inside Corners: Preformed.

H. Colors: As selected by Architect from manufacturer’s full range.

2.02 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 EXECUTION

3.01 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

C. Do not install resilient products until materials are the same temperature as space where they are to be installed.

D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.02 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

3.03 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

END OF SECTION

SECTION 09 90 00

PAINTING AND COATING

TABLE OF CONTENTS

SECTION 09 90 00

PAINTING AND COATING

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This Section specifies coating systems, surface preparations, and application requirements for coating systems.

B. Definitions:

1. Specific coating terminology used in this Section is in accordance with definitions contained in ASTM D16, ASTM D3960, and the following definitions.
    a. Definitions:
        1) Abrasive: Material used for blast cleaning, such as sand, grit or shot.
        2) Abrasive Blast Cleaning: Cleaning/surface preparation by abrasive propelled at high speed.
        3) Anchor Pattern: Profile or texture of prepared surface(s).
        4) ANSI: American National Standards Institute.
        5) Bug Holes: Small cavities, usually not exceeding 15 mm in diameter, resulting from entrapment of air bubbles in the surface of formed concrete during placement and compaction.
        6) Coating/Paint/Lining Thickness: The total thickness of primer, intermediate and/or finish coats.
        7) Coating System Applicator (CSA): A generic reference to the specialty subcontractor or subcontractors retained by the Contractor to install the coating systems specified in this Section.
        8) Coating System Manufacturer (CSM): Refers to the acceptable coating system manufacturer, abbreviated as the CSM.
        9) Coating System Manufacturer's Technical Representative(s) (CTR): Refers to the technical representative(s) of the acceptable Coating System Manufacturer and is abbreviated as CTR.
        10) Dew point: Temperature of a given air/water vapor mixture at which condensation starts.
        11) Dry Film Thickness (DFT): Depth of cured film, usually expressed in mils (0.001 inch). Use this definition as opposed to existing definition.
        12) Drying Time: Time interval between application and curing of material.
        13) Dry to Recoat: Time interval between application of material and ability to receive next coat.
        14) Dry to Touch: Time interval between application of material and ability to touch lightly without damage.
        15) Feather Edging: Reducing the thickness of the edge of paint.
        16) Feathering: Operation of tapering off the edge of a point with a comparatively dry brush.

17) Field Coat: The application or the completion of application of the coating system after installation of the surface at the site of the work.
18) Hold Point: A defined point, specified in this Section, at which work shall be halted for inspection.
19) Holiday: a discontinuity, skip, or void in coating or coating system film that exposes the substrate.
20) Honeycomb: Segregated condition of hardened concrete due to non-consolidation.
21) ICRI: International Concrete Repair Institute.
22) Incompatibility: Inability of a coating to perform well over another coating because of bleeding, poor bonding, or lifting of old coating; inability of a coating to perform well on a substrate.
23) Laitance: A layer of weak, non-durable concrete containing cement fines that is brought to the surface through bleed water because of concrete finishing and/or over-finishing.
24) Mil: 0.001 inch.
25) NACE: National Association of Corrosion Engineers.
26) Overspray: Dry spray, particularly such paint that failed to strike the intended surface.
27) Pinhole: A small diameter discontinuity in a coating or coating system film that is typically created by outgassing of air from a void in a concrete substrate resulting in exposure of the substrate or a void between coats.
28) Pot Life: Time interval after mixing of components during which the coating can be satisfactorily applied.
29) Resurfacer/Resurfacing Material: A layer of cementitious and/or resin-base material used to fill or otherwise restore surface continuity to worn or damaged concrete surfaces.
30) Shelf Life: Maximum storage time for which a material may be stored without losing its usefulness.
31) Shop Coat: One or more coats applied in a shop or plant prior to shipment to the site of the work, where the field or finishing coat is applied.
32) Spreading Rate: Area covered by a unit volume of paint at a specific thickness.
33) SSPC: The Society for Protective Coatings.
34) Stripe Coat: A separate coat of paint applied to all weld seems, pits, nuts/bolts/washers and edges by brush. This coat shall not be applied until any previous coat(s) have cured and, once applied, shall be allowed to cure prior to the application of the subsequent coat(s).
35) Surface Saturated Dry (SSD): Refers to concrete surface condition where the surface is saturated (damp) without the presence of standing water.
36) Tie Coat: An intermediate coat used to bond different types of paint coats. Coatings used to improve the adhesion of a succeeding coat.
37) Touch-Up Painting: The application of paint on areas of painted surfaces to repair marks, scratches, and areas where the coating has deteriorated to restore the coating film to an unbroken condition.
38) TPC: Technical Practice Committee.

39) Volatile Organic Compound (VOC) Content: The portion of the coating that is a compound of carbon, is photochemically reactive, and evaporates during drying or curing, expressed in grams per liter (g/l) or pounds per gallon (lb/gal).

40) Immersion: Refers to a service condition in which the substrate is below the waterline or submerged in water or wastewater at least intermittently if not constantly.

41) Weld Splatter: Beads of metal scattered near seam during welding.

42) Wet Film Thickness (WFT): The primer or coating film's thickness immediately following application. Wet film thickness is measured in mils or thousandths of an inch (0.001 inch) and is abbreviated WFT.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ANSI/ASC 29.4 Exhaust Systems	Abrasive Blasting Operations – Ventilation and Safe Practice
ANSI/NSF 61	Drinking Water System Components Health Effects
ANSI B74.18	Grading of Certain Abrasive Grain on Coated Abrasive Material
ASTM D16	Standard Terminology for Paint, Related Coatings, Materials, and Applications
ASTM D2200 (SSPC-VIS1)	Pictorial Surface Preparation Standards for Painting Steel Surfaces
ASTM D3960	Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM D4262	Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces
ASTM D4263	Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4414	Standard Practice for Measurement of Wet Film Thickness by Notch Gages
ASTM D4417	Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM D4541	Standard Test Methods for Pull-Off Strength of Coatings On Metal Substrates Using Portable Adhesion Testers
ASTM D4787	Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates

Reference	Title
ASTM D5162	Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates
ASTM D7234	Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Adhesion Testers.
ASTM E337	Standard Test Method for Measuring Humidity With a Psychrometer
ASTM F1869	Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
FS 595b	Federal Standard Colors
ICRI 03732	Guideline for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays
NACE Publication 6D-163	A Manual for Painter Safety
NACE Publication 6F-163	Surface Preparation of Steel or Concrete Tank/Interiors
NACE Publication 6G-164 A	Surface Preparation Abrasives for Industrial Maintenance Painting
NACE Standards	January 1988 Edition of the National Association of Corrosion Engineers, TPC.
NACE Standard RP0188	Standard Recommended Practice – Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
NACE Standard RP0288	Standard Recommended Practice, Inspection of Linings on Steel and Concrete
NACE Standard RP0892	Standard Recommended Practice, Linings Over Concrete in Immersion Service
NACE Publication TPC2	Coatings and Linings for Immersion Service
NAPF 500-03	Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings
NAPF 500-03-04	Abrasive Blast Cleaning for Ductile Iron Pipe
NAPF 500-03-05	Abrasive Blast Cleaning for Cast Ductile Iron Fittings
OSHA 1910.144	Safety Color Code for Marking Physical Hazards
OSHA 1915.35	Standards – 29CFR - Painting
SSPC	Paint Application Specification No. 1.
SSPC-AB 1	Mineral and Slag Abrasives
SSPC-PA 1	Shop, Field, and Maintenance Painting of Steel
SSPC-PA 2	Measurement of Dry Coating Thickness with Magnetic Gages
SSPC-PA 9	Measurement of Dry Coating Thickness on Cementitious Substrates Using Ultrasonic Gages
SSPC-PA Guide 1	Guide for Illumination of Industrial Painting Project
SSPC-PA Guide 3	A Guide to Safety in Paint Application
SSPC-PA Guide 6	Guide for Containing Debris Generated During Paint Removal Operations
SSPC-PA Guide 11	Guide for Coating Concrete
SSPC SP1	Solvent Cleaning
SSPC SP2	Hand Tool Cleaning
SSPC SP3	Power Tool Cleaning
SSPC SP5	White Metal Blast Cleaning
SSPC SP6	Commercial Blast Cleaning
SSPC SP7	Brush-Off Blast Cleaning
SSPC SP10	Near-White Blast Cleaning
SSPC SP11	Power Tool Cleaning to Bare Metal
SSPC SP12	Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultra-High Pressure Water Jetting Prior to Recoating
SSPC SP13	Surface Preparation of Concrete
SSPC-TR2	Wet Abrasive Blast Cleaning
SSPC-TU-3	Overcoating

Reference	Title
SSPC-TU-4	Field Methods for Retrieval and Analysis of Soluble Salts on Substrates.
SSPC V2	Systems and Specifications: Steel Structures Painting Manual, Volume 2
SSPC-VIS 1	Visual Standard for Abrasive Blast Cleaned Steel
SSPC-VIS 3	Visual Standard for Power and Hand – Tool Cleaned Steel
SSPC-VIS 4	Visual Standards (Waterjetting)
SSPC-VIS 5	Visual Standards (Wet Abrasive Blast Cleaning)
WPCF Manual of Practice No. 17	Paints and Protective Coatings for Wastewater Treatment Facilities. Guide and Paint Application Specifications.

B. Standardization:
   1. Materials and supplies provided shall be the standard products of CSMs. Materials in each coating system shall be the products of a single CSM.
   2. The standard products of CSMs other than those specified may be acceptable when it is demonstrated to the Construction Manager that they are equal in composition, durability, usefulness, and convenience for the purpose intended. Requests for consideration of CSMs other than those specified in this Section will be considered, provided the following minimum conditions are met. Such requests are not a substitution for submittals after the alternative CSMs have been considered and accepted.
      a. The proposed coating system shall use an equal or greater number of separate coats to achieve the required total dry film thickness.
      b. The proposed coating system shall use coatings of the same generic type as that specified including curing agent type.
      c. Requests for consideration of products from CSMs other than those specified in this Section shall include information listed in paragraph 1.04, demonstrating that the proposed CSM's product is equal to the specified coating system.
      d. The Contractor and the proposed alternative CSM shall provide a list of references for the proposed product where the coating of the same generic type has been applied. The reference list shall include the project name, city, state, owner, phone number of owner; coating system reference and number from this Section 09 90 00; type of facility in which it was used, generic type, and year coating was applied.

C. Quality Control Requirements:
   1. The Contractor is responsible for the workmanship and quality of the coating system installation. Inspections by the Construction Manager or the CTR will not relieve or limit the Contractor's responsibilities.
   2. The Contractor's methods shall conform to requirements of this specification and the standards referenced in this Section. Changes in the coating system installation requirements will be allowed only with the written acceptance of the Construction Manager before work commences.
   3. Only personnel who are trained by the CTR specifically for this contract or who are approved by the CSM specifically for this contract shall be allowed to perform the coating system installation specified in this Section.
   4. Contaminated, outdated, diluted materials, and/or materials from previously opened containers shall not be used.

5. For repairs, the Contractor shall provide the same products, or products recommended by the CSM, as used for the original coating.
6. The Contractor shall identify the points of access for inspection by the Owner or the Construction Manager. The Contractor shall provide ventilation, ingress and egress, and other means necessary for the Construction Manager's personnel to access safely the work areas.
7. The Contractor shall conduct the work so that the coating system is installed as specified and shall inspect the work continually to ensure that the coating system is installed as specified. Coating system work that does not conform to the specifications or is otherwise not acceptable shall be corrected as specified.
8. The Contractor shall complete the Coating System Inspection Checklist, Form 09 90 00-A, included in Section 01 99 90, for coating system installations. Follow the sequential steps required for proper coating system installation as specified and as listed in the Coating System Inspection Checklist. For each portion of the work, install the coating system and complete sign-offs as specified prior to proceeding with the next step. After completing each step as indicated on the Coating System Inspection Checklist, the Contractor shall sign the checklist indicating that the work has been installed and inspected as specified.
9. The Contractor shall provide written daily reports that present, in summary form, test data, work progress, surfaces covered, ambient conditions, quality control inspection test findings, and other information pertinent to the coating system installation.

D. Inspection at Hold Points:
   1. The Contractor shall conduct inspections at Hold Points during the coating system installation and record the results from those inspections on Form 09 90 00-A. The Contractor shall coordinate such Hold Points with the Construction Manager such that the Construction Manager may observe Contractor's inspections on a scheduled basis. The Contractor shall provide the Construction Manager a minimum of two (2) hours of notice prior to conducting Hold Point Inspections. The Hold Points shall be as follows:
      a. Environment and Site Conditions. Prior to commencing an activity associated with coating system installation, the Contractor shall measure, record, and confirm acceptability of ambient air temperature and humidity as well as other conditions such as proper protective measures for surfaces not to be coated and safety requirements for personnel. The acceptability of the weather and/or environmental conditions within the structure shall be determined by the requirements specified by the CSM of the coating system being used.
      b. Conditions Prior to Surface Preparation. Prior to commencing surface preparation, the Contractor shall observe, record, and confirm that oil, grease, and/or soluble salts have been eliminated from the surface.
      c. Monitoring of Surface Preparation. Spot checking of degree of cleanliness, surface profile, and surface pH testing, where applicable. In addition, the compressed air used for surface preparation or blow down cleaning shall be checked to confirm it is free from oil and moisture.
      d. Post Surface Preparation – Upon completion of the surface preparation, the Contractor shall measure and inspect for proper degree of cleanliness and surface profile as specified in this Section 09 90 00 and in the CSM's written instructions.

e. Monitoring of Coatings Application – The Contractor shall inspect, measure, and record the wet film thickness and general film quality (visual inspection) for lack of runs, sags, pinholes, holidays, etc. as the application work proceeds.

f. Post Application Inspection – The Contractor shall identify defects in application work including pinholes, holidays, excessive runs or sags, inadequate or excessive film thickness and other problems as may be observed.

g. Post Cure Evaluation – The Contractor shall measure and inspect the overall dry film thickness. The Contractor shall conduct a DFT survey, as well as perform adhesion testing, holiday detection, or cure testing as required based on the type of project and the specific requirements in this Section 09 90 00 and/or in the CSM's written instructions.

h. Follow-up to Corrective Actions and Final Inspection. The Contractor shall measure and reinspect corrective coating work performed to repair defects identified at prior Hold Points. This activity also includes final visual inspection along with follow-up tests such as holiday detection, adhesion tests, and DFT surveys.

1.03 DELIVERY AND STORAGE

A. General:

1. Materials shall be delivered to the job site in their original, unopened containers. Each container shall be properly labeled. Materials shall be handled and stored to prevent damage to or loss of label.
2. Labels on material containers shall show the following information:
   a. Name or title of product.
   b. CSM's batch number.
   c. CSM's name.
   d. Generic type of material.
   e. Application and mixing instructions.
   f. Hazardous material identification label.
   g. Shelf life expiration date.
3. Materials shall be stored in enclosed structures and shall be protected from weather and excessive heat or cold in accordance with the CSM's recommendations. Flammable materials shall be stored in accordance with state and local requirements.
4. Containers shall be clearly marked indicating personnel safety hazards associated with the use of or exposure to the materials.
5. Material Safety Data Sheets (MSDS) for each material shall be provided to the Construction Manager.
6. The Contractor shall store and dispose of hazardous waste according to federal, state and local requirements. This requirement specifically addresses waste solvents and coatings.

1.04 SUBMITTALS:

A. General:

1. Provide in accordance with Section 01 33 00:

a. A copy of this specification section, with addendum updates included, and referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate specification compliance or marked to indicate requested deviations from specification requirements or those parts which are to be provided by the Contractor or others. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined shall signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for requested deviations to the specification requirements shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.

b. CSM's current printed recommendations and product data sheets for coating systems including:

1) Volatile organic compound (VOC) data.
2) Surface preparation recommendations.
3) Primer type, where required.
4) Maximum dry and wet-mil thickness per coat.
5) Minimum and maximum curing time between coats, including atmospheric conditions for each.
6) Curing time before submergence in liquid.
7) Thinner to be used with each coating.
8) Ventilation requirements.
9) Minimum atmospheric conditions during which the paint shall be applied.
10) Allowable application methods.
11) Maximum allowable moisture content.
12) Maximum shelf life.

c. Affidavits signed and sealed by an officer of the CSM's corporation, attesting to full compliance of each coating system component with current and promulgated federal, state, and local air pollution control regulations and requirements.

d. Material Safety Data Sheets (MSDS) for materials to be delivered to the job site, including coating system materials, solvents, and abrasive blast media.

e. List of cleaning and thinner solutions allowed by the CSMs.

f. Storage requirements including temperature, humidity, and ventilation for Coating System Materials as recommended by the CSMs.

g. CSM's detailed, written instructions for coating system treatment and graphic details for coating system terminations in the structures to be coated including pipe penetrations, metal embedments, gate frames, and other terminations to be determined from the contract drawings. This information shall also include detail treatment for coating system at joints in concrete.

h. The Contractor and CSA shall provide a minimum of five project references each including contact name, address, and telephone number where similar coating work has been performed by their companies in the past five years.

1.05 RESPONSIBILITIES OF THE CTR

A. General:

1. The Contractor shall retain or obtain the services of the CTR to be on site to perform the Contractor and/or CSA application training and to routinely inspect and verify in writing that the application personnel have successfully performed surface preparation, filler/surface application, coating system application, and Quality Control Inspection in accordance with this Section 09 90 00 and to warrantable level of quality. This must include checking the required degree of cleanliness, surface pH for concrete substrates, surface profile of substrates, proper mixing of coating materials, application (including checking the wet and dry film thickness of the coating systems), proper cure of the coating systems, and proper treatment of coating systems at terminations, transitions, and joints and cracks in substrates. Refer to paragraph 1.05 Coating System Installation Training. for further details on these CTR requirements. This inspection is in addition to the inspection performed by the Contractor in accordance with this Section 09 90 00.

B. Coating System Installation Training:

1. Provide a minimum of 8 hours of classroom and off site training for application and supervisory personnel (both the Contractor's and CSA's). Provide training to a minimum of two supervisory personnel from the CSA and one supervisor from the Contractor. Alternatively, the CTR shall provide a written letter from the CSM stating that the application personnel (listed by name) who shall perform coating work are approved by the CSM without further or additional training.

2. One CTR can provide training for up to fourteen application personnel and three supervisory personnel at one time. The training shall include the following as a minimum:

   a. A detailed explanation of mixing, application, curing, and termination details.

   b. Hands-on demonstration of how to mix and apply the coating systems.

   c. A detailed explanation of the ambient condition requirements (temperature and humidity) and surface preparation requirements for application of the coating system as well as a detailed explanation of re-coat times, cure times, and related ambient condition requirements.

   d. When training is performed, the CTR shall provide a written letter stating that training was satisfactorily completed by the personnel listed by name in the letter.

C. Coating System Inspection:
   1. While on site to routinely inspect and verify, the CTR shall perform the following activities to confirm acceptability and conformance with the specifications:
      a. Inspect ambient conditions during various coating system installation at hold points for conformance with the specified requirements.
      b. Inspect the surface preparation of the substrates where the coating system will terminate or will be applied for conformance to the specified application criteria.
      c. Inspect preparation and application of coating detail treatment (for example, terminations at joints, metal embedments in concrete, etc.).
      d. Inspect application of the filler/surface materials for concrete and masonry substrates.
      e. Inspect application of the primers and finish coats including wet and dry film thickness of the coatings.
      f. Inspect coating systems for cure.
      g. Review adhesion testing of the cured coating systems for conformance to specified criteria.
      h. Review coating system continuity testing for conformance to specified criteria.
      i. Inspect and record representative localized repairs made to discontinuities identified via continuity testing.
      j. Conduct a final review of completed coating system installation for conformance to the specifications.
      k. Prepare and submit a site visit report following each site visit that documents the acceptability of the coating work in accordance with the CSM's Recommendations.

D. Final Report:
   1. Upon completion of coating work for the project, the CTR shall prepare a final report. That report shall summarize daily test data, observations, drawings, and photographs in a report to be submitted in accordance with paragraph 2.02. Include substrate conditions, ambient conditions, and application procedures, observed during the CTR's site visits. Include a statement that the completed work was performed in accordance with the requirements of this Section 09 90 00 and the CSM's recommendations.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
   1. Notwithstanding the listing of product names in this Section 09 90 00, the Contractor shall provide affidavits, signed and sealed by an officer of the CSM's corporation, attesting to full compliance of each coating system component with current and promulgated federal, state, and local air pollution control regulations and requirements. No coatings shall be applied to a surface until the specified affidavits have been submitted and have been reviewed and accepted. Failure to comply with this requirement shall be cause for rejection and removal of such materials from the site.

2. The following list specifies the material requirements for coating systems. Coating systems are categorized by generic name followed by an identifying abbreviation. If an abbreviation has a suffix number, it is for identifying subgroups within the coating system. Coating Systems E-5 and E-6 shall be NSF 61 certified.

Material Requirements for Coating Systems

Coating System	CSM	First Coat(s)	Finish Coat(s)
Epoxy Coatings			
E-1	PPG PMC	Amerlock 2/400 Series	Amerlock 2/400 Series
	Carboline	Carboguard 890	Carboguard 890
	International Paint/ICI *	Devran 224 HS	Devran 224
	Sherwin Williams	Macropoxy 646	Macropoxy 646
	Tnemec	Series V69	Series V69
E-1-G	PPG PMC	Amerlock 2/400 Series	Amerlock 2/400 Series
	Carboline	Carboguard 894	Carboguard 894
	International Paint/ICI *	Devran 223/224HS	Devran 224HS
	Sherwin Williams	Macropoxy 646 Epoxy B67-600	Macropoxy 646 Epoxy B67-600
	Tnemec	Series V27 or V69	Series V69
E-2	PPG PMC	Amerlock 2/400 Series	Amerlock 2/400 Series
	Carboline	Carboguard 890	Carboguard 890
	International Paint/ICI	Bar-Rust 236	Bar-Rust 236
	Sherwin Williams	Sea Guard 6000 Epoxy N11-400	Sea Guard 6000 Epoxy N11-400
	Tnemec	Series V27 or V69	Series V69
E-3	PPG PMC	Amerlock 2/400 Series	Amerlock 2/400 Series
	Carboline	Carboguard 890	Carboguard 890
	International Paint/ICI	Bar-Rust 236	Bar-Rust 236
	Sherwin Williams	Sea Guard 6000 Epoxy N11-400	Sea Guard 6000 Epoxy N11-400
	Tnemec	Series V69	Series V69
E-4	PPG PMC	Amerlock 2/400 Series	Amerlock 2/400 Series
	Carboline	Carboguard 890	Carboguard 890
	International Paint/ICI	Bar-Rust 236	Bar-Rust 236
	Sherwin Williams	Macropoxy 646	Macropoxy 646
	Tnemec	Series V69	Series V69
E-5	PPG PMC	Amercoat 395FD	Amercoat 395FD
	Carboline	Carboguard 691	Carboguard 691
	International Paint/ICI	Bar-Rust 233H	Bar-Rust 233H
	Sherwin Williams	Macropoxy 646	Macropoxy 646
	Tnemec	Series V69	Series V69
E6	PPG PMC	Amercoat 395FD	Amercoat 395FD
	Carboline	Carboguard 691	Carboguard 691

Material Requirements for Coating Systems

Coating System	CSM	First Coat(s)		Finish Coat(s)
	International Paint/ICI	Tru-Glaze 4408 - WB		Tru-Glaze 4408 - WB
	Sherwin Williams	Macropoxy 646		Macropoxy 646
	Tnemec	Series V69		Series V69
E7	PPG PMC	Amercoat 385		Amercoat 385
	Carboline	Sanitile 120		Carboguard 890
	International Paint/ICI	Bar-Rust 236		Bar-Rust 236
	Sherwin Williams	Macropoxy 646		Macropoxy 646
	Tnemec	Series V69		Series V69
E8	PPG PMC	Amercoat 385		Amercoat 385
	Carboline	Carboguard 1340		Carboguard 1340
	International Paint/ICI	Prep and Prime (Gripper)		Tru-Glaze 4408 - WB
	Sherwin Williams	Macropoxy 646		Macropoxy 646
	Tnemec	Series 201		Series 201
E-9	PPG PMC	Amercoat 395 FD		Amercoat 395 FD
	Carboline	Carboguard 890		Carboguard 890
	International Paint/ICI	Bar-Rust 231		Bar-Rust 231
	Sherwin Williams	Sea Guard 6000 Epoxy N11-400		Sea Guard 6000 Epoxy N11-400
	Tnemec	Series 104		Series 104
E-9-C	PPG PMC	Amercoat 395 FD		Amercoat 395 FD
	Carboline	Carboguard 890		Carboguard 890
	International Paint/ICI	Bar-Rust 231		Bar-Rust 231
	Sherwin Williams	Sea Guard 6000 Epoxy N11-400		Sea Guard 6000 Epoxy N11-400
	Tnemec	Series 104		Series 104
E-10	PPG PMC	Amerlock 2/400 Series		Amerlock 2/400 Series
	Carboline	Carboguard 890		Carboguard 890
	International Paint/ICI	Bar-Rust 236		Bar-Rust 236
	Sherwin Williams	Macropoxy 646		Macropoxy 646
	Tnemec	Series V69		Series V69
Specialty Epoxy Linings				
EA-1	Carboline	Plasite 4500S		Plasite 4500S
	Sauereisen	Sewergard 210S		Sewergard 210S
	Tnemec	Series 435		Series 435
Coating System	CSM	Base Coat	Filler/Surfacer	Glaze Coat
EA-2	Carboline Carboguard	Plasite 4500S	Carboguard 510	Plasite 4500S
	Sauereisen	Sewergard 210S	Series 209 HB	Sewergard 210S
	Tnemec	Series 435	Series 218	Series 435

Material Requirements for Coating Systems

Coating System	CSM	First Coat(s)		Finish Coat(s)
EA-3	Carboline	N/A	Carboguard 510	Plasite 5371
	Sauereisen	N/A	Series 209 HB	Sewergard 210T
	Tnemec	N/A	Series 218	Series 434

Coating System	CSM	Primer	Base Coat	Glaze Coat
EA-4	Carboline	N/A	Plasite 5371	Plasite 4500S
	Sauereisen	N/A	Sewergard 210T	Sewergard 210G
	Tnemec	N/A	Series 434	Series 435

Coating System	CSM	Primer	Filler/ Surfacer	Base Coat w/Scrim Cloth	Saturation Coat w/Silica Sand	Finish Coats
EA-5	Tnemec	Series 201	Series 218	Series 239	Series 239	Series 282
	Carboline	Semstone 110/110EP	Carboguard 510	Semstone 145	Semstone 145	Semstone 145

Elastomeric Coatings			
EC-1	Carboline	Carboguard 671	Polibrid 705 (2 coats)
	Sherwin Williams	Corobond 100	Envirolastic 170 (2 coats)
	Tnemec	Series 1	Series 406 (2 coats)
EC-2	Carboline	Carboguard 671	Polibrid 705 (2 coats)
	Sherwin Williams	Corobond 100	Envirolastic 520PW (2 coats)
	Tnemec	Series V69	Series 264

Epoxy Flooring Systems				
Coating System	CSM	Primer	Intermediate Coat	Finish Coat
EF-1	Stonhard	Stonhard Standard Primer	Stonshield Undercoat and Broadcoat	Stoneshield Sealer
	Tnemec	Series 238	Series 238 with Broadcoat	Series 284 Clear
EF-2	Stonhard	Stonhard Standard Primer	Stonclad GS	Stonkote GS-4
	Tnemec	Series 238	Series 238	Series 280

Epoxy Polyurethane				
		Primer Coat(s)	Intermediate Coat(s)	
EU-1	PPG PMC	Amercoat	Amercoat 385	Amercoat 450H
	Carboline	Carbozinc 859	Carboguard 890	Carbothane 134 VOC
	International Paint/ICI	Cathacoat 313	Devran 233 or 224HS	Devthane 379
	Sherwin Williams	Zinc Clad IV	Macropoxy 646	Hi Solids Polyurethane
	Tnemec	Series 90-97	Series V69	Series 1075
EU-1-FRP	PPG PMC	Amerlock 2/400 Series		Amershield VOC
	Carboline	Carbocrylic 120		Carbothane 134 VOC
	International Paint/ICI	Devran 223/224		Devthane 378H
	Sherwin Williams	Macropoxy 646		High Solids Polyurethane
	Tnemec	Series V27		Series 1075

Material Requirements for Coating Systems

Coating System	CSM	First Coat(s)	Finish Coat(s)
Grease			
G	Texaco	N/A	Rust Inhibitive Grease
	Chevron	N/A	E.P. Roller Grease
High Heat			
HH-1	High Temperature Coatings, Inc.	Hi Temp 1027	1000 VS (any color)
HH-2	High Temperature Coatings, Inc.	Hi Temp 1027	1000 VS (black or aluminum)
Latex Acrylic			
L-1	PPG PMC	Amercoat 148	Amercoat 220
	Carboline	Carbocrylic 120	Carbocrylic 3359
	International Paint/ICI	UH Gripper 3210	Dulux Pro 1406
	Sherwin Williams	Loxon Acrylic Primer	Sher Cryl HPA
	Tnemec	Series 1028 or 1029	Series 1028 or 1029
L-2	PPG PMC	Amercoat 220	Amercoat 220
	Carboline	Carbocrylic 120	Carbocrylic 3359
	International Paint/ICI	Prep and Prime Gripper	Ultrahide 250-1406
	Sherwin Williams	Sher Cryl HPA	Sher Cryl HPA
	Tnemec	Series 1028 or 1029	Series 1028 or 1029
L-3	PPG PMC	Amercoat 148	Amercoat 220
	Carboline	Carbocrylic 3359 DTM	Carbocrylic 3359 DTM
	International Paint/ICI	Devflex 4020 PF	Dulux Pro 1406
	Sherwin Williams	Procryl Primer	Sher Cryl HPA
	Tnemec	Series 1028 or 1029	Series 1028 or 1029
L-4	PPG PMC	Amercoat 148	Amercoat 220
	Carboline	Sanitile 120	Sanitile 155
	International Paint/ICI	Prepared Prime Gripper	Ultrahide 250-1406
	Sherwin Williams	Prep Rite ProBlock	Sher Cryl HPA
	Tnemec	Series 1028 or 1029	Series 1028 or 1029
Miscellaneous			
M-1	Carboline	Carbowrap Priming Paste	Tape A, B, or C (temp. dependent)
	Denso	Denso Paste	Densyl Tape
	Trenton	Waxtape Primer	#1 Wax Tape
M-2	Carboline	Carbomastic 15	Carbomastic 15
	International Paint/ICI	Bar-Rust 231 (231K 9100)	Bar-Rust 231 (231K 9100)
	Sherwin Williams	Epoxy Mastic Aluminum II	Epoxy Mastic Aluminum II
	Tnemec	Series 135 (1243)	Series 135 (1243)

Material Requirements for Coating Systems

Coating System	CSM	First Coat(s)	Finish Coat(s)
Penetrating Stain			
	CSM	Primer	Finish
S-1	Carboline	Carbocrete Sealer WB	Carbocrete Sealer WB
	International Paint/ICI	Groundworks	Groundworks
	Sherwin Williams	H&C Acrylic Concrete Stain	H&C Acrylic Concrete Stain
	Tnemec	Series 617	Series 617
S-2	Tnemec	N/A	Series 636 Dur A Pell 20
	Curecrete Chemical Company	N/A	Ashford Formula
S-3	Tnemec	N/A	Series V626 Dur A Pell GS
S-4	Tnemec Professional Products of Kansas	N/A N/A	Series V626 Dur A Pell GS PWS-15 Super

**See CSM's Product Data Sheets for acceptable thinners for VOC compliance or do not thin.*

2.02 PRODUCT DATA

A. General:
   1. Prior to application of coatings, submit letter(s) from the CTR(s) identifying the application personnel who have satisfactorily completed training as specified in paragraph 1.05 or a letter from the CSM stating that personnel who shall perform the work are approved by the CSM without need for further or additional training.
   2. Submit reports specified in paragraph 1.02 Quality Control Requirements and 1.05 Coating System Inspection when the work is underway.
   3. Submit the Coating System Inspection Checklists, using Form 09 90 00-A, included in Section 01 99 90, for the coating work.
   4. CTR final report in accordance with paragraph 1.05 Final Report.

PART 3 EXECUTION

3.01 COATINGS

A. General:
   1. Coating products shall not be used until the Construction Manager has accepted the affidavits specified in paragraphs 1.04 and 2.01, the Construction Manager has inspected the materials, and the CTR has trained the Contractor and CSA in the surface preparation, mixing and application of each coating system.
   2. Erect and maintain protective enclosures as stipulated per SSPC-Guide 6 Guide for Containing Debris Generated During Paint Removal Operations.

B. Shop and Field Coats:

1. Shop Applied Prime Coat: Except as otherwise specified, prime coats may be shop-applied or field-applied. Shop-applied primer shall be compatible with the specified coating system and shall be applied at the minimum dry film thickness recommended by the CSM. Data sheets identifying the shop primer used shall be provided to the on-site coating application personnel. Adhesion tests shall be performed on the shop primer as specified in paragraph 3.01 Adhesion Confirmation. Damaged, deteriorated and poorly applied shop coatings that do not meet the requirements of this Section 09 90 00 shall be removed and the surfaces recoated. If the shop primer coat meets the requirements of this Section 09 90 00, the field coating may consist of touching up the shop prime coat and then applying the finish coats to achieve the specified film thickness and continuity.
2. Field Coats: Field coats shall consist of one or more prime coats and one or more finish coats to build up the coating to the specified dry film thickness. Unless otherwise specified, finish coats shall not be applied until other work in the area is complete and until previous coats have been inspected.
3. Adhesion Confirmation: The Contractor shall perform an adhesion test after proper cure in accordance with ASTM D3359 to demonstrate that (1) the shop applied prime coat adheres to the substrate, and (2) the specified field coatings adhere to the shop coat. Test results showing an adhesion rating of 5A on immersed surfaces and 4A or better on other surfaces shall be considered acceptable for coatings 5 mils or more in thickness (Method A). Test results showing an adhesion rating of 5B on immersed surfaces and 4B or better on other surfaces shall be considered acceptable for coating thicknesses less than 5 mils.

C. Application Location Requirements:

1. Equipment, Nonimmersed: Items of equipment, or parts of equipment that are not immersed in service, shall be shop primed and then finish coated in the field after installation with the specified or acceptable color. If the shop primer requires topcoating within a specified period, the equipment shall be finish coated in the shop and then touch-up painted after installation. If equipment removal and reinstallation is required for the project, touch-up coating work shall be performed in the field following installation.
2. Equipment, Immersed: Items of equipment, or parts and surfaces of equipment that are immersed when in service, with the exception of pumps and valves, shall have surface preparation and coating work performed in the field. Coating systems applied to immersed equipment shall be pinhole free.
3. Steel Water Tanks: The interior surfaces of steel water tanks or reservoirs shall have surface preparation and coating work performed in the field.

3.02 PREPARATION

A. General:

1. Surface preparations for each type of surface shall be in accordance with the specific requirements of each coating specification sheet (COATSPEC) and the following. In the event of a conflict, the COATSPEC sheets shall take precedence.

2. Surfaces to be coated shall be clean and dry. Before applying coating or surface treatments, oil, grease, dirt, rust, loose mill scale, old weathered coatings, and other foreign substances shall be removed. Oil and grease shall be removed before mechanical cleaning is started. Where mechanical cleaning is accomplished by blast cleaning, the abrasive used shall be washed, graded and free from contaminants that might interfere with the adhesion of the coatings. The air used for blast cleaning shall be sufficiently free of oil and moisture so as not to cause detrimental contamination of the surfaces to be coated.
3. Where deemed necessary by the Owner's representative, a NACE International certified coatings inspector, provided by the Owner, will inspect and approve surfaces to be coated before application of a coating. Surface defects identified by the inspector shall be corrected by the Contractor at no additional cost to the Owner.
4. Cleaning and painting shall be scheduled so that dust and spray from the cleaning process shall not fall on wet, newly coated surfaces. Hardware, hardware accessories, nameplates, data tags, machined surfaces, sprinkler heads, electrical fixtures, and similar uncoated items which are in contact with coated surfaces shall be removed or masked prior to surface preparation and painting operations. Following completion of coating, removed items shall be reinstalled. Equipment adjacent to walls shall be disconnected and moved to permit cleaning and painting of equipment and walls and, following painting, shall be replaced and reconnected.

B. Blast Cleaning:
1. When abrasive blast cleaning is required to achieve the specified surface preparation the following requirements for blast cleaning materials and equipment shall be met:
    a. Used or spent blast abrasive shall not be reused on this project.
    b. The compressed air used for blast cleaning shall be filtered and shall contain no condensed water and no oil. Moisture traps shall be cleaned at least once every four hours or more frequently as required to prevent moisture from entering the supply air to the abrasive blasting equipment.
    c. Oil separators shall be installed just downstream of compressor discharge valves and at the discharge of the blast pot discharges. These shall be checked on the same frequency as the moisture traps as defined above.
    d. Regulators, gauges, filters, and separators shall be in use on compressor air lines to blasting nozzles times during this work.
    e. An air dryer or desiccant filter drying unit shall be installed which dries the compressed air prior to blast pot connections. This dryer shall be used and maintained for the duration of surface preparation work.
    f. The abrasive blast nozzles used shall be of the venturi or other high velocity type supplied with a minimum of 100 psig air pressure and sufficient volume to obtain the blast cleaning production rates and cleanliness/specified.
    g. The Contractor shall provide ventilation for airborne particulate evacuation (meeting pertinent safety standards) to optimize visibility for both blast cleaning and inspection of the substrate during surface preparation work.
    h. If, between final surface preparation work and coating system application, contamination of prepared and cleaned metallic substrates occurs, or if the prepared substrates' appearance darkens or changes color, recleaning by water blasting, reblasting and abrasive blast cleaning shall be required until the specified degree of cleanliness is reclaimed.

i. The Contractor is responsible for dust control and for protection of mechanical, electrical, and other equipment adjacent to and surrounding the work area.

C. Solvent Cleaning:
   1. Any solvent wash, solvent wipe, or cleaner used, including but not limited to those used for surface preparation in accordance with SSPC SP-1 Solvent Cleaning and shall be of the emulsifying type which emits no more than 340 g/l VOCs for AIM regions, 250 g/l for CARB regions and 100 g/l for SCAQMD regions, contains no phosphates, is biodegradable, removes no zinc, and is compatible with the specified primer.
   2. Clean white cloths and clean fluids shall be used in solvent cleaning.

D. Metallic Surfaces:
   1. Metallic surfaces shall be prepared in accordance with applicable portions of surface preparation specifications of the Society for Protective Coatings (SSPC) specified for each coating system. See Coat Spec for each coating system in this Section 09 90 00. The profile depth of the surface to be coated shall be in accordance with the COATSPEC requirements in this Section measured by Method C of ASTM D4417. Blast particle size shall be selected by the Contractor to produce the specified surface profile. The solvent in solvent cleaning operations shall be as recommended by the CSM.
   2. Preparation of metallic surfaces shall be based upon comparison with SSPC-VIS1-89 (ASTM D2200), and as described in the Coat Spec for each coating system. If dry abrasive blast cleaning is selected and to facilitate inspection, the Contractor shall, on the first day of cleaning operations, abrasive blast metal panels to the standards specified. Plates shall measure a minimum of 8-1/2 inches by 11 inches. Panels meeting the requirements of the specifications shall be initialed by the Contractor and the Construction Manager and coated with a clear non-yellowing finish. One of these panels shall be prepared for each type of abrasive blasting and shall be used as the comparison standard throughout the project.
   3. Blast cleaning requirements for steel, ductile iron and stainless steel substrates are as follows:
      a. Steel piping shall be prepared in accordance with SSPC SP-6 (Commercial Blast Cleaning) and primed before installation. Ductile iron piping surfaces including fittings shall be prepared in accordance with NAPF 500-03, NAPF 500-03-04, and NAPF 500-03-05.
      b. Stainless steel surfaces shall be abrasive blast cleaned to leave a clean uniform appearance with a minimum surface profile of 1.5 to 2.5 mils that is uniform.
      c. Remove traces of grit, dust, dirt, rust scale, friable material, loose corrosion products or embedded abrasive from substrate by vacuum cleaning prior to coating application.
      d. Care must be taken to prevent contamination of the surface after blasting from worker's fingerprints, deleterious substances on workers' clothing, or from atmospheric conditions.
      e. Ambient environmental conditions in the enclosure must be constantly monitored and maintained to ensure the degree of cleanliness is held and no "rust back" occurs prior to coating material application.

E. Concrete Surfaces:
   1. Inspection of concrete surfaces prior to surface preparation and surface preparation of concrete surfaces shall be performed in accordance with SSPC-SP13 (also called NACE 6).
   2. Prepare substrate cracks, areas requiring resurfacing and perform detail treatment including but not limited to, terminating edges, per CSM recommendations. This shall precede surface preparation for degree of cleanliness and profile.
   3. The surface profile for prepared concrete surfaces to be coated shall be evaluated by comparing the profile of the prepared concrete with the profile of graded abrasive paper, as described in ANSI B74.18 or by comparing the profile with the ICRI 03732 (surface profile replicas). Surface profile requirements shall be in accordance with the Coat Spec requirements and the CSM's recommendations.
   4. Surface cleanliness of prepared concrete substrates shall be inspected after cleaning, preparation, and/or drying, but prior to making repairs or applying a coat in the coating system. If concrete surfaces are repaired, they shall be reinspected for surface cleanliness prior to application of the coating system.
   5. Surface preparation of concrete substrates shall be accomplished using methods such as dry abrasive blast cleaning, high, or ultra high-pressure water blast cleaning in accordance with SSPC-SP-13. The selected cleaning method shall produce the requirements set forth below.
      a. A clean substrate that is free of calcium sulfate, loose coarse or fine aggregate, laitance, loose hydrated cement paste, and otherwise deleterious substances shall be achieved. Blast cleaning and other means necessary shall be used to open up air voids or bugholes to expose their complete perimeter. Leaving shelled over, hidden air voids beneath the exposed concrete surface is not acceptable. Concrete substrate must be dry prior to the application of filler/surface or coating system materials.
      b. Acceptable surface preparation must produce a concrete surface with a minimum pH of 8.0 to be confirmed by surface pH testing. If after surface preparation, the surface pH remains below 8.0, perform additional water blasting, cleaning, or abrasive blast cleaning until additional pH testing indicates an acceptable pH level.
      c. Following inspection by the Contractor of the concrete surface preparation, thoroughly vacuum clean concrete surfaces to be coated to remove loose dirt, and spent abrasive (if dry blast cleaning is used) leaving a dust free, sound concrete substrate. Debris produced by blast cleaning shall be removed from the structures to be coated and disposed of legally off site by the Contractor.
   6. Should abrasive blast cleaning or high or ultrahigh pressure water blasting not remove degraded concrete, chipping or other abrading tools shall be used to remove the deteriorated concrete until a sound, clean substrate is achieved which is free of calcium sulfate, loose coarse or fine aggregate, laitance, loose hydrated cement paste, and otherwise deleterious substances. Concrete substrates must be dry prior to the application of filler/surfacers or coating system materials.
   7. Surface cleanliness of prepared concrete substrates shall be inspected after cleaning, preparation, and/or drying, but prior to application of coating materials. If concrete surfaces are repaired, they shall be reinspected for surface cleanliness and required surface profile prior to application of the coating system.

8. Moisture content of concrete to be coated shall be tested in accordance with ASTM D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method and ASTM F 1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride. The ASTM D4263 plastic sheet test shall be conducted at least once for every 500 sq. ft. of surface area to be coated. The presence of any moisture on plastic sheet following test period constitutes a non-acceptable test. For concrete surfaces to be coated which are on the negative or back side of concrete walls or structures exposed to soils (back filled) or immersed and waterproofed in accordance with Section 07 10 00, perform calcium chloride tests in accordance with ASTM F-1869 once for each 500 sq. ft. of surface area to be coated. Comply with CSM's written recommendations regarding acceptance/non-acceptance of moisture vapor emissions.

F. Masonry Surfaces:
   1. Prepare masonry surfaces such as Concrete Masonry Units (CMU) to remove chalk, loose dirt, dried mortar splatter, dust, peeling, or loose existing coatings, or otherwise deleterious substances to leave a clean, sound substrate.
   2. Be certain masonry surfaces are dry prior to coating application. If pressure washing or low-pressure water blast cleaning is used for preparation, allow the masonry to dry for at least 5 days under dry weather conditions or when the minimum ambient temperature is 70 degrees F prior to coating application work.

G. Fiberglass Reinforced Plastic (FRP) Surfaces:
   1. Prepare FRP surfaces by sanding to establish uniform surface roughness and to remove gloss from the resin in the FRP. Next, vacuum clean to remove loose FRP dust, dirt, and other materials. Next, solvent clean using clean white rags and allow solvent to evaporate completely before application of coating materials.

3.03 APPLICATION

A. Workmanship:
   1. Coated surfaces shall be free from runs, drips, ridges, waves, laps, and brush marks. Coats shall be applied to produce an even film of uniform thickness completely coating corners and crevices.
   2. The Contractor's equipment shall be designed for application of the materials specified. Compressors shall have suitable traps and filters to remove water and oils from the air. A paper blotter test shall be performed by the Contractor when requested by the Construction Manager to determine if the air is sufficiently free of oil and moisture so as not to produce deteriorating effects on the coating system. The amount of oil and moisture in spray air shall be less than the amount recommended by the CSM. Spray equipment shall be equipped with mechanical agitators, pressure gages, and pressure regulators, and spray nozzles of the proper sizes.
   3. Each coat of coating material shall be applied evenly and sharply cut to line. Care shall be exercised to avoid overspraying or spattering paint on surfaces not to be coated. Glass, hardware, floors, roofs, and other adjacent areas and installations shall be protected by taping, drop cloths, or other suitable measures.
   4. Coating applications method shall be conventional or airless spray, brush or roller, or trowel as recommended by CSM.

5. Allow each coat to cure or dry thoroughly, according to CSM's printed instructions, prior to recoating.
6. Vary color for each successive coat for coating systems when possible.
7. When coating complex steel shapes, prior to overall coating system application, stripe coat welds, edges of structural steel shapes, metal cut-outs, pits in steel surfaces, or rough surfaces with the primer coat. This involves applying a separate coat using brushes or rollers to ensure proper coverage. Stripe coat via spray application is not permitted.

B. Coating Properties, Mixing and Thinning:
   1. Coatings, when applied, shall provide a satisfactory film and smooth even surface. Glossy undercoats shall be lightly sanded to provide a surface suitable for the proper application and adhesion of subsequent coats. Coating materials shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings consisting of two or more components shall be mixed in accordance with the CSM's instructions. Where necessary to suit the conditions of the surface, temperature, weather and method of application, the coating may be thinned as recommended by the CSM immediately prior to use. The volatile organic content (VOC) of the coating as applied shall comply with prevailing air pollution control regulations. Unless otherwise specified, coatings shall not be reduced more than necessary to obtain the proper application characteristics. Thinner shall be as recommended by the CSM.

C. Atmospheric Conditions:
   1. Coatings shall be applied only to surfaces that are dry, and only under conditions of evaporation rather than condensation. Coatings systems shall not be applied during rainy, misty weather, or to surfaces upon which there is frost or moisture condensation. During damp weather, when the temperature of the surface to be coated is within 10 degrees F of the dew point, forced dehumidification equipment may be used to maintain a temperature of minimum 40 degrees F and 10 degrees F above the dew point for the surfaces to be coated, the coated surface, and the atmosphere in contact with the surface. These conditions shall be maintained for a period of at least 8 hours or as recommended by the CSM. Where conditions causing condensation are severe, dehumidification equipment, fans, and/or heaters shall be used inside enclosed areas to maintain the required atmospheric and surface temperature requirements for proper coating application and cure.

D. Concrete Substrate Temperatures and Detail Treatment:
   1. When the surface temperatures of the concrete substrates to be coated are rising or when these substrates are in direct sunlight, outgassing of air from the concrete may result in bubbling, pinhole formations, and/or blistering in the coating system. The application of the filler/surface and the coating system will only be allowed during periods of falling temperature. This will require that application of the filler/surface and coating system shall only occur during the cooler evening hours. Contractor shall include any cost for working outside of normal hours in the bid.

2. Should bubbles, pinholes, or discontinuities form in the applied coating system material, they shall be repaired as recommended by the CSM. Should pinholes develop in the filler/surfacer material or in the first coat of the coating material, the pinholes shall be repaired in accordance with the CSM's recommendations prior to application of the next coat of material. Whenever pinholes occur, the air void behind or beneath the pinhole shall be opened up completely and then completely filled with the specified filler/surfacer material. Next, the coated area around the pinhole repair shall be abraded and the coating reapplied over that area.
3. Perform application detail work per CSM's current written recommendations and/or drawings.

E. Protection of Coated Surfaces:
1. Items that have been coated shall not be handled, worked on, or otherwise disturbed, until the coating is completely dry and hard. After delivery at the site, and upon permanent erection or installation, shop-coated metalwork shall be recoated or retouched with specified coating when it is necessary to maintain the integrity of the film.

F. Method of Coating Application:
1. Where two or more coats are required, alternate coats shall contain sufficient compatible color additive to act as indicator of coverage, or the alternate coats shall be of contrasting colors. Color additives shall not contain lead, or lead compounds, which may be destroyed or affected by hydrogen sulfide or other corrosive gas, and/or chromium.
2. Mechanical equipment, on which the equipment manufacturer's coating is acceptable, shall be touch-up primed and coated with two coats of the specified coating system to match the color scheduled. Electrical and instrumentation equipment specified in Divisions 26 and 40 shall be coated as specified in paragraph 3.03 Electrical and Instrumentation Equipment and Materials.
3. Coatings shall not be applied to a surface until it has been prepared as specified. The primer or first coat shall be applied by brush to ferrous surfaces that are not blast-cleaned. Coats for blast-cleaned ferrous surfaces and subsequent coats for nonblast-cleaned ferrous surfaces may be either brush or spray applied. After the prime coat is dry, pinholes and holidays shall be marked, repaired in accordance with CSM's recommendations and retested before succeeding coats are applied. Unless otherwise specified, coats for concrete and masonry shall be brushed, rolled, or troweled.

G. Film Thickness and Continuity:
1. WFT of the first coat of the coating system and subsequent coats shall be verified by the Contractor, following application of each coat.
2. The surface area covered per gallon of coating for various types of surfaces shall not exceed those recommended by the CSM. The first coat, referred to as the prime coat, on metal surfaces refers to the first full paint coat and not to solvent wash, grease emulsifiers or other pretreatment applications. Coatings shall be applied to the thickness specified, and in accordance with these specifications. Unless otherwise specified, the average total thickness (dry) of a completed protective coating system on exposed metal surfaces shall be not less than 1.25 mils per coat. The minimum thickness at any point shall not deviate more than 25 percent from the required average. Unless otherwise specified, no less than two coats shall be applied.

3. In testing for continuity of coating about welds, projections (such as bolts and nuts), and crevices, the Construction Manager shall determine the minimum conductivity for smooth areas of like coating where the dry-mil thickness has been accepted. This conductivity shall be the minimum required for these rough or irregular areas. Pinholes and holidays shall be recoated to the required coverage.
4. The ability to obtain specified film thickness is generally compromised when brush or roller application methods are used and, therefore, more coats may need to be applied to achieve the specified dry film thickness.
5. For concrete substrates, the Contractor shall apply a complete skim coat of the specified filler/surfacer material over the entire substrate prior to application of the coating system. This material shall be applied such that all open air voids and bugholes in the concrete substrate are completely filled prior to coating application.

H. Special Requirements:
1. Before erection, the Contractor shall apply all but the final finish coat to interior surfaces of roof plates, roof rafters and supports, pipe hangers, piping in contact with hangers, and contact surfaces that are inaccessible after assembly. The final coat shall be applied after erection. Structural friction connections and high tensile bolts and nuts shall be coated after erection. Areas damaged during erection shall be hand-cleaned or power-tool cleaned and recoated with primer coat prior to the application of subsequent coats. Touch-up of surfaces shall be performed after installation. Surfaces to be coated shall be clean and dry at the time of application. Except for those to be filled with grout, the underside of equipment bases and supports that have not been galvanized shall be coated with at least two coats of primer specified for system E-2 prior to setting the equipment in place. Provide coating system terminations at leading edges and transitions to other substrates in accordance with the CSM's recommendations or detail drawings.

I. Electrical and Instrumentation Equipment and Materials:
1. Electrical and instrumentation equipment and materials shall be coated by the equipment manufacturer as specified below.
    a. Finish: Electrical equipment shall be treated with zinc phosphate, bonderized or otherwise given a rust-preventive treatment. Equipment shall be primed, coated with enamel, and baked. Minimum dry film thickness shall be 3 mils.
        1) Unless otherwise specified, instrumentation panels shall be coated with system E-1 for indoor mounting and system EU-1 for outdoor mounting.
        2) Before final acceptance, the Contractor shall touch up scratches on equipment with identical color coating. Finish shall be smooth, free of runs, and match existing finish. Prior to touching up scratches, Contractor shall fill them with an appropriate filler material approved by the CSM.
    b. Color: Exterior color of electrical equipment shall be FS 26463 (ANSI/NSF 61) light gray. Interior shall be painted FS 27880 white. Nonmetallic electrical enclosures and equipment shall be the equipment manufacturer's standard grey color.
        1) Exterior color of instrumentation panels and cabinets shall be FS 26463 light gray. Cabinet interiors shall be FS 27880, white.

J. Soluble Salt Contamination of Metallic Substrates:
   1. Contractor shall test in accordance with SSPC-TU-4 metallic substrates to be coated that have been exposed to seawater or coastal air or to industrial fallout of particulate or other sources of soluble chlorides (such as wastewater exposure). If testing indicates detrimental levels of soluble salts, those in excess of 25 ppm, the Contractor shall clean and prepare these surfaces to remove the soluble salts.

3.04 CLEANUP

A. General:
   1. Upon completion of coating, the Contractor shall remove surplus materials, protective coverings, and accumulated rubbish, and thoroughly clean surfaces and repair overspray or other coating-related damage.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

A. General:
   1. Coating systems for different types of surfaces and general service conditions for which these systems are normally applied are specified on the following COATSPEC sheets. Surfaces shall be coated in accordance with the COATSPEC to the system thickness specified. Coating systems shall be as specified in paragraph 3.06. In case of conflict between the schedule and the COATSPECS, the requirements of the schedule shall prevail.
   2. Coating Specification Sheets included in Table A are included this paragraph 3.05.

Table A Coating Specification Sheets

Coating System ID	Coating Material	Surface	Service Condition
E-1	Epoxy	Metal	Interior; exterior, covered, not exposed to direct sunlight, non-corrosive exposure.
E-1-G	Epoxy	Galvanized Steel	Interior; exterior, covered non-corrosive exposure. Do not use in immersion service.
E-2	Epoxy	Metal	Immersed, nonpotable; non-immersed, moderately corrosive environment, color required.
E-3	Epoxy	Concrete or Masonry	Immersed, nonpotable; non-immersed, corrosive environment, color required.
E-4	Epoxy	Concrete, masonry, plaster, gypsum board	Interior
E-5 (NSF 61 certified)	Epoxy	Metal	Interior potable water tanks and reservoirs and other metal components in contact with water being treated and stored for potable use.
E-6 (NSF 61 certified)	Epoxy	Concrete	Interior potable water tanks and reservoirs and other metal components in contact with water being treated or stored.
E-7	Epoxy	Plastic	Interior; exterior covered, not exposed to direct sunlight.
E-8	Clear epoxy	Wood	Interior
E-9	Epoxy	Metal	Immersed, nonpotable; non-immersed, corrosive environment, color required. (Not for Biogenic Sulfide Corrosion areas.)

Table A Coating Specification Sheets

Coating System ID	Coating Material	Surface	Service Condition
E-9-C	Epoxy	Concrete or masonry	Immersed, nonpotable; non-immersed, moderately corrosive environment, color required. (Not for Biogenic Sulfide Corrosion areas.)
E-10	Polyamidoamine epoxy	Metal or concrete	Below grade (buried).
EF-1	Amine Epoxy Broadcast Floor Coating	Concrete Floors	Light duty, wheeled traffic, frequent foot traffic, mildly corrosive.
EF-2	Amine Epoxy Troweled Floor Coating	Concrete Floors	Heavy-duty, wheeled traffic, frequent foot traffic, wet and moderately corrosive.
EA-1	Blended Amine Cured Epoxy	Metal	Immersed, nonpotable; non-immersed, corrosive environment, color not required especially for headspace environments that are corrosive due to biogenic sulfide corrosion.
EA-2	Blended Amine Cured Epoxy	Concrete or masonry	Immersed, nonpotable; non-immersed, corrosive environment, color not required, new construction especially for headspace environments that are corrosive due to biogenic sulfide corrosion.
EA-3	Blended Amine Cured Epoxy	Concrete or Masonry	Immersed, nonpotable; non-immersed, corrosive environment, color not required, new or existing construction, especially for headspace environments that are corrosive due to biogenic sulfide corrosion.
EA-4	Blended Amine Cured Epoxy – For Very Corrosive Conditions	Concrete or Masonry Potable	Non-immersed or immersed, very corrosive environment. Very high H_2S conditions.
EA-5	Novolac Epoxy Lining	Concrete	Secondary containment for spills of HFS acid or ferric chloride.
G	Grease	Metal	Ferrous Metal: Ferrous metal surfaces shall be prepared in accordance with SSPC SP-1 (Solvent Cleaning.)
HH-1	Proprietary Primer Plus Silicone Topcoat	Metal	Temperature to 750 degrees F.
HH-2	Proprietary Primer Plus Silicone Topcoat (black or aluminum only)	Metal	Temperature to 1200 degrees F.
L-1	Latex	Concrete, masonry, plaster, gypsum board	Interior and Exterior including existing exterior coated concrete.
L-2	Latex	PVC and CPVC pipe	Exterior, direct sunlight exposure.
L-3	Latex-Direct to Metal	Ferrous Metal	Interior or Exterior
L-4	Latex	Wood	Interior
M-1	Petrolatum based mastic or wax based wrapping tapes	Metal	Below grade (buried) or where little to no surface preparation can be performed on piping or structural steel.
M-2	Epoxy mastic or equal	Ferrous Metal	Interior, corrosive environment, confined enclosures, where minimal surface preparation is possible.
EU-1	Zinc-epoxy-polyurethane system	Ferrous Metal	Exterior, exposed to direct sunlight, moderately corrosive non-immersed.
EU-1-FRP	Specialty Primer plus Polyurethane Finish Coat	Exterior of FRP pipe and tanks, etc.	Exterior, exposed to direct sunlight, non-immersed.

Table A Coating Specification Sheets

Coating System ID	Coating Material	Surface	Service Condition
EC-1	Hybrid Polyurethane	Concrete or dense masonry where existing crack or joint movement is suspected of propagating through rigid cured epoxy coatings	Service Condition: Interior or exterior, exposed to direct sunlight or not, corrosive (immersion pH 4.0 or lower and/or headspace pH 4.0 or lower and/or gaseous H_2S concentrations between 10 and 150 ppm typically.)
EC-2 (NSF-61)	Modified Polyurethane	Concrete or dense masonry where existing crack or joint movement is suspected due to thermal conditions and would propagate through rigid epoxy coating systems and/or where NSF-61 certification is required	Interior or exterior, submerged or non-submerged indirect sunlight – moderately corrosive.
S-1	Penetrating acrylic stain, color required	Concrete	Non-immersed, exposure to moisture and sunlight.
S-2	Silane/Siloxane or Blended Sealer	Concrete Floors	Wet, non-immersed, non-corrosive. Interior or exterior for waterproofing.
S-3	RTV Silicone Rubber Based Sealer	Concrete or Masonry Walls	Exterior or Interior – Weathering Exposure, Non-Corrosive.
S-4	Acrylic Co-polymer Blend	Concrete Floors	Wet, non-immersed, non-corrosive, interior for oil and water repellent.

Coating System Specification Sheets (COATSPEC)

A.	**Coating System Identification: E-1**	
1.	Coating Material:	Epoxy
2.	Surface:	Metal
3.	Service Condition:	Interior; exterior, covered, not exposed to direct sunlight, non-corrosive exposure.
4.	Surface Preparation:	
a.	General:	Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning surfaces in accordance with SSPC SP-2 (Hand Tool Cleaning). Damaged shop coated areas shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) to achieve a uniform surface profile of 2.0 to 2.5 mils and spot primed with the primer specified. Shop epoxy primed surfaces shall require light abrasive and vacuum cleaning blasting prior to receiving finish coats.
b.	Ferrous Metal:	Bare ferrous metal surfaces shall be prepared in accordance with SSPC SP-6 (Commercial Blast Cleaning) to achieve a uniform, surface profile of 2.0 to 2.5 mils.
		Ferrous metal with rust bleeding shall be cleaned in accordance with SSPC SP-1 (Solvent Cleaning). Areas of rust penetration shall be spot blasted to SSPC SP-10 (Near White Blast) (to achieve the 2.0- to 2.5-mil surface profile) and spot primed with the specified primer. For ductile iron surfaces, refer to the requirements in paragraph 3.02 Metallic Surfaces.
c.	Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to achieve uniform, minimum surface profile 1.0 to 1.5 mils.
5.	Application:	Field
a.	General:	Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.
b.	Ferrous Metal:	Prime coats shall be an epoxy primer compatible with the specified finish coats and applied in accordance with the written instructions of the CSM.
c.	Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal shall be cleaned prior to the application of the prime coat in accordance with SSPC SP-1 (Solvent Cleaning).
6.	System Thickness:	10 mils dry film.
7.	Coatings:	
a.	Primer:	One coat at CSM's recommended dry film thickness.
b.	Finish:	One or more coats at CSM's recommended dry film thickness per coat to achieve the specified system thickness.
B.	**Coating System Identification: E-1-G**	
1.	Coating Material:	Epoxy
2.	Surface:	Galvanized Steel
3.	Service Condition:	Interior; exterior, covered, non-corrosive exposure. Do not use in immersion service.
4.	Surface Preparation:	
a.	General:	Damaged galvanized steel areas with exposed ferrous metal and/or rusted shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) or Power Tool Cleaned to Bare Metal in accordance with SSPC-SP-11 to achieve a uniform 1.0- to 1.5-milprofile and spot primed with the primer specified.
b.	Galvanized Metal:	Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) impart a 1- to 2-milprofile to the galvanized steel surfaces. Where this cannot be performed, prepare by abrading in accordance with SSPC-SP-3, Power Tool Cleaning to impart a 1.0- to 1.5-mil profile uniformly to the galvanized steel surfaces.
5.	Application:	Field
a.	General:	Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.

b. Galvanized Metal:	Nonferrous and galvanized metal shall be cleaned prior to the application of the prime coat in accordance with SSPC SP-1 (Solvent Cleaning).
6. System Thickness:	5 to 8 mils dry film.
7. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Finish:	One or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
	If the coated galvanized steel is to be exposed to ultraviolet light, apply one polyurethane top coat from coating system EU-1 over the second coat of the two epoxy coats specified.
C. Coating System Identification: E-2	
1. Coating Material:	Epoxy
2. Surface:	Metal
3. Service Condition:	Immersed, nonpotable; non-immersed, moderately corrosive environment, color required.
4. Surface Preparation:	
a. Ferrous Metal:	Ferrous metal surfaces shall be prepared in accordance with SSPC SP-5 (White Metal Blast Cleaning) to achieve a uniform surface profile of 2.0 to 2.5 mils.
	Damaged shop coating shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) and vacuum cleaning and spot primed with the primer specified. Shop epoxy primed surfaces shall require light abrasive blasting or abrading prior to receiving finish coats if the maximum recoat time for the primer has been exceeded. This cleaning must produce a uniform 1.0- to 1.5-mil profile in the intact shop primer. For ductile iron surfaces, refer to the requirements in paragraph 3.02 Metallic Surfaces.
b. Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to achieve a uniform surface profile of 1.0 to 1.5 mils. Galvanized steel with this E-2 coating system shall not be used in immersion service in wastewater.
5. Application:	Field
a. General:	Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.
b. Ferrous Metal:	Prime coat shall be an epoxy primer compatible with the specified finish coats.
c. Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal, non-immersed, shall be coated prior to the application of the prime coat with a grease emulsifying agent in accordance with the CSM's written instructions. Nonferrous metal to be immersed shall not be painted. Galvanized metal shall not be immersed even if it is painted.
6. System Thickness:	16 mils dry film.
7. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Finish:	Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
D. Coating System Identification: E-3	
1. Coating Material:	Epoxy
2. Surface:	Concrete or masonry
3. Service Condition:	Immersed, nonpotable; non-immersed, corrosive environment, color required.
4. Surface Preparation:	
a. Concrete:	Concrete surfaces shall be allowed to cure for at least 28 days and allowed to dry to the moisture content recommended by the CSM before coating work proceeds. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Except as otherwise specified, loose concrete, form oils, surface hardeners, curing compounds, and laitance shall

	be removed from surfaces by abrasive blasting and chipping, and voids and cracks shall be repaired as specified in Section 03 30 00. Surface preparation can be performed by abrasive blast cleaning or water blast cleaning and must achieve a uniform concrete surface profile of CSP3 in accordance with ICRI 03732. After cleaning, air voids or bugholes in the concrete shall be filled with a surfacer or block filler compatible with the specified primer and finish coats.
b. Masonry:	Masonry surfaces shall be allowed to cure for at least 28 days after being constructed and be allowed to dry to the moisture content recommended by the CSM. Holes or other joint defects shall be filled with a material compatible with the primers and finish coats or shall be filled with masonry mortar that shall cure for at least 28 days. Loose or splattered mortar shall be removed by scraping and chipping.
	Masonry surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign, loose, and deleterious substances.
	Muriatic acid shall not be used. After cleaning, masonry surfaces shall be sealed or filled with a sealer or block filler compatible with the specified primer.
5. Application:	Field
a. General:	Apply filler/surfacer as recommended by CSM to fill bugholes and air voids or block texture, etc. leaving a uniformly filled surface that does not produce blowholes or outgassing causing pinholing of the coating system. Filler/surfacers shall dry a minimum of 48 hours prior to application of prime coat or as required by the CSM.
	Prime coat shall be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.
	Drying time between coats shall be as recommended by CSM.
6. System Thickness:	15 mils dry film.
7. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Finish:	Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
E. Coating System Identification: E-4	
1. Coating Material:	Epoxy
2. Surfaces:	Concrete, masonry, plaster, gypsum board.
3. Service Condition:	Interior
4. Surface Preparation:	
a. Concrete:	Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Loose concrete, form oils, surface hardeners, curing compounds and laitance shall be removed from surfaces, and voids and cracks shall be repaired as specified in Section 03 30 00. Surface preparation shall produce a concrete surface profile of CSP-2 in accordance with ICRI 03732. After cleaning, air voids or bugholes in the concrete shall be filled with a surfacer or block filler compatible with the specified primer and finish coats.
b. Masonry:	Masonry surfaces shall be allowed to age for at least 28 days. Holes or other joint defects shall be filled with mortar and repointed. Loose or splattered mortar shall be removed by scrapping and chipping. Masonry surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances. Muriatic acid shall not be used. After cleaning, exterior masonry surfaces shall be sealed or filled with a sealer or block filler compatible with the specified primer.
c. Plaster:	Plaster surfaces shall be dry, clean, and free from grit, loose plaster, and surface irregularities. Cracks and holes shall be repaired with acceptable patching materials, keyed to existing surfaces, and sandpapered smooth. Surfaces shall be cleaned with clean water by washing and scrubbing to remove foreign and deleterious substances.

5. Application:	Field
a. General:	Block Filler shall be multiple component epoxy block filler or an acrylic based or waterborne epoxy based block filler and shall dry a minimum of 48 hours prior to primer application or as required by the CSM.
	Prime coat shall be thinned and applied as recommended by CSM, provided the coating as applied complies with prevailing air pollution control regulations.
	Drying time between coats shall be as recommended by CSM.
6. System Thickness:	10 mils dry film, excluding block filler and sealer.
7. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Finish:	One or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
F. Coating System Identification: E-5 (NSF 61 certified)	
1. Coating Material:	Epoxy
2. Surface:	Metal
3. Service Condition:	Interior potable water tanks and reservoirs and other metal components in contact with water being treated and stored for potable use.
4. Surface Preparation:	
a. Ferrous Metal:	Ferrous metal surfaces shall be prepared in accordance with SSPC SP-5 (White Metal Blast Cleaning) to achieve a uniform surface profile of 2.0 to 2.5 mils.
	Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning surfaces in accordance with SSPC SP-2 (Hand Tool Cleaning) or SSPC-SP-3 (Power Tool Cleaning). Damaged shop coating shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) and spot primed with the primer specified. Cleaning shall produce a surface profile of 2.0 to 2.5 mils. Shop epoxy primed surfaces shall require light abrasive blasting or abrading prior to receiving finish coats if the maximum recoat limit has been exceeded for the primer. This cleaning shall produce a uniform surface profile of 1.0 to 1.5 mils in the intact primer.
b. Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to achieve a 1.0- to 1.5-mil profile that is uniform.
5. Application:	Field
a. General:	Prime coat shall be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.
b. Ferrous Metal:	Prime coat shall be an epoxy primer compatible with the specified finish coats.
c. Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal above the high water elevation shall be cleaned prior to the application of the prime coat in accordance with SSPC SP-1 (Solvent Cleaning).
6. System Thickness:	10 mils dry film.
7. Coatings:	
a. Primer:	One coat at the CSM's recommended dry film thickness.
b. Finish:	One or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
G. Coating System Identification: E-6 (NSF 61 certified)	
1. Coating Material:	Epoxy
2. Surface:	Concrete
3. Service Condition:	Interior potable water tanks and reservoirs and other metal components in contact with water being treated or stored.
4. Surface Preparation:	
a. Concrete:	Concrete surfaces shall be allowed to cure for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content may be tested by

	the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Except as otherwise specified, loose concrete, form oils, surface hardeners, curing compounds, and laitance shall be removed from surfaces by abrasive blasting and chipping, and voids and cracks shall be repaired as specified in Section 03 30 00. Abrasive blast cleaning or water blast cleaning methods can be used and must produce a uniform concrete surface profile of a CSP-3 in accordance with ICRI 03732. After cleaning, air voids or bugholes in the concrete shall be filled with a surfacer or block filler compatible with the specified primer and finish coats.
b. Masonry:	Masonry surfaces shall be allowed to cure for at least 28 days. Holes or other joint defects shall be filled with mortar and repointed and allowed to cure for 28 days or shall be filled with materials compatible with the primer and finish coats. Loose or splattered mortar shall be removed by scraping and chipping.
	Masonry surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances.
	Muriatic acid shall not be used. After cleaning, masonry surfaces shall be sealed or filled with a sealer or block filler compatible with the specified primer.
5. Application:	Field
a. General:	Surfacer or block filler shall dry a minimum of 48 hours prior to application of prime coat or as recommended by the CSM. Prime coat shall be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.
	Drying time between prime coat and finish coat shall be as recommended by CSM.
6. System Thickness:	15 mils dry film.
7. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Finish:	Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
H. Coating System Identification: E-7	
1. Coating Material:	Epoxy
2. Surface:	Plastic
3. Service Condition:	Interior; exterior covered, not exposed to direct sunlight.
4. Surface Preparation:	Plastic shall be prepared in accordance with SSPC SP-1 (Solvent Cleaning) and light sanding to produce a uniform surface roughness(uniform surface profile of 1.0 to 1.5 mils) on the plastic.
5. Application:	Field
6. System Thickness:	5 mils dry film.
7. Coatings:	One or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
I. Coating System Identification: E-8	
1. Coating Material:	Clear epoxy
2. Surface:	Wood
3. Service Condition:	Interior
4. Surface Preparation:	Wood surfaces shall be cleaned of dirt, oil or other foreign substances with mineral spirits, scrapers, sandpaper or wire brush. Finished surfaces exposed to view shall be smoothed by planing or sandpapering. Millwork shall be sandpapered and given a coat of the specified exterior primer on sides before installation. Built-in surfaces of windowsills shall be double primed. Glazing rabbets and beads in exterior sash and doors shall be double primed. Small, dry, seasoned knots shall be surfaced scraped, sandpapered, and thoroughly cleaned and shall be given a thin coat of a clear knot sealer before application of the priming coat. Large, open, unseasoned knots, and beads or streaks of pitch shall be scraped off; however, if the pitch is still soft, it shall be removed with mineral spirits or turpentine, and the resinous area

	shall be coated with knot sealer prior to priming. After priming, holes and imperfections shall be filled with putty or plastic wood, colored to match the finish coat, allowed to dry and sandpapered smooth.
5. Application:	Field
a. General:	Prime coat shall be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.
6. System Thickness:	4 mils
7. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Finish:	One or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
J. Coating System Identification: E-9	
1. Coating Material:	Epoxy
2. Surface:	Metal
3. Service Condition:	Immersed, nonpotable; non-immersed, corrosive environment, color required. (Not for Biogenic Sulfide Corrosion areas.)
4. Surface Preparation:	
a. Ferrous Metal:	Ferrous metal surfaces shall be prepared in accordance with SSPC SP-5 (White Metal Blast Cleaning) to achieve a uniform surface profile of 2.5 to 3.0 mils.
	Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning surfaces in accordance with SSPC SP-2 (Hand Tool Cleaning) or SSPC-SP-3 (Power Tool Cleaning). Damaged shop coating shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) to achieve a uniform surface profile of 2.5 to 3.0 mils and spot primed with the primer specified. Shop epoxy primed surfaces shall require light abrasive blasting or abrading to achieve a uniform surface profile of 1.0 to 1.5 mils in the intact shop primer prior to receiving finish coats if the maximum recoat time for the primer has been exceeded. For ductile iron surfaces, refer to the requirements in paragraph 3.02 Metallic Surfaces.
b. Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to achieve a 1.5- to 2.0-mil profile that is uniform. Galvanized steel with this E-2 coating system shall not be used in immersion service in wastewater.
5. Application:	Field
a. General:	Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.
b. Ferrous Metal:	Prime coat shall be an epoxy primer compatible with the specified finish coats.
c. Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal, non-immersed, shall be coated prior to the application of the prime coat with a grease emulsifying agent in accordance with the CSM's written instructions. Non-ferrous metal to be immersed shall not be painted. Galvanized metal shall not be immersed even if it is painted with this coating system.
6. System Thickness:	15 to 20 mils dry film.
7. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Finish:	Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
K. Coating System Identification: E-9-C	
1. Coating Material:	Epoxy
2. Surface:	Concrete or masonry
3. Service Condition:	Immersed, nonpotable; non-immersed, moderately corrosive environment, color required. (Not for Biogenic Sulfide Corrosion areas.)
4. Surface Preparation:	

a. Concrete:	Concrete surfaces shall be allowed to cure for at least 28 days following initial concrete placement and allowed to dry to the moisture content recommended by the CSM before coating work proceeds. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Except as otherwise specified, loose concrete, form oils, surface hardeners, curing compounds, and laitance shall be removed from surfaces by abrasive blasting and chipping, and voids and cracks shall be repaired as specified in Section 03 30 00. Cleaning can be performed using abrasive blast cleaning or water blast cleaning methods to produce a minimum concrete surface profile of CSP-3 in accordance with ICRI 03732. After cleaning, all air voids or bugholes in the concrete shall be filled with a surfacer or block filler compatible with the specified primer and finish coats.
b. Masonry:	Masonry surfaces shall be allowed to cure for at least 28 days after being constructed and be allowed to dry to the moisture content recommended by the CSM. Holes or other joint defects shall be filled with a material compatible with the primers and finish coats or shall be filled with masonry mortar that shall cure for at least 28 days. Loose or splattered mortar shall be removed by scraping and chipping.
	Masonry surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances.
	Muriatic acid shall not be used. After cleaning, masonry surfaces shall be sealed or filled with a sealer or block filler compatible with the specified primer.
5. Application:	Field
a. General:	Apply filler/surfacer as recommended by CSM to fill bugholes and air voids or block texture, etc. leaving a uniformly filled surface that does not produce blowholes or outgassing causing pinholing of the coating system.
	Filler/Surfacers shall dry a minimum of 48 hours prior to application of prime coat or as required by the CSM.
	Prime coat shall be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.
	Drying time between coats shall be as recommended by CSM.
6. System Thickness:	16 to 20 mils dry film.
7. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Finish:	Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
L. Coating System Identification: E-10	
1. Coating Material:	Polyamidoamine epoxy
2. Surface:	Metal or concrete
3. Service Condition:	Below grade (buried, exterior) in contact with soil
4. Surface Preparation:	
a. Ferrous Metal:	Ferrous metal surfaces shall be prepared in accordance with SSPC SP-5 (White Metal Blast Cleaning).
b. Nonferrous Metal:	Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to achieve a uniform surface profile of 2.0 to 2.5 mils.
c. Concrete:	Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Except as otherwise specified, loose concrete and laitance shall be removed from surfaces by abrasive blasting and chipping, and voids and cracks shall be repaired as specified in Section 03 30 00. Concrete surface preparation can be performed using abrasive blast cleaning or water blast cleaning methods and must achieve a concrete surface profile of CSP-3 in accordance with ICRI

	03732.
5. Application:	Field
6. System Thickness:	16 mils
7. Coating:	Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
M. Coating System Identification: EF-1	
1. Coating Material:	Epoxy Resin Based Floor Coating
2. Surface:	Concrete Floors
3. Service Condition:	For interior light duty applications light wheel traffic, mostly foot traffic, and mildly corrosive. Mainly for wear resistance, aesthetics, and cleanability. Non-slip texture can be varied depending on wetness of exposure. Test patches to be installed for deciding on level of non-slip texture required.
4. Surface Preparation:	Concrete floor slabs shall be allowed to age for at least 28 days and must meet a moisture vapor transmission rate of less than 3.0 lbs. of moisture per 24 hours per 1,000 SF in accordance with ASTM F1869. It is also essential that a well-sealed and intact vapor barrier has been installed beneath all slabs on grade to receive this floor coating system. Except as otherwise specified, loose concrete, curing compounds, and laitance shall be removed by abrasive blast cleaning or preferably by shotblasting. Surface preparation shall produce a clean sound concrete substrate with a concrete surface profile of CSP-6 minimum in accordance with ICRI 03732. Surface preparation shall be in accordance with SSPC-SP-13.
	Additionally, all coating termination and transition details shall be prepared in accordance with the CSM's standard detail drawings. This includes coating termination details, coating transitions at vertical and vertical to horizontal corners, coating terminations at joints, concrete crack treatment, pipe penetration treatment, coating terminations at metal embedments in the concrete substrate, and other details. The CSM's standard detail drawings shall be submitted for all such coating applications. If standard details are not available for a given detail treatment, the CSM shall be required to produce one at no additional cost to the owner, the engineer, or any other party.
	If wet abrasive or water blasting surface preparation methods were used, the concrete substrate shall be allowed to dry under warm conditions (minimum of 75 degrees F) for at least 5 days prior to coating application. Following surface preparation work and dry-out, all surfaces to be coated shall be vacuum cleaned to remove all loose dirt, dust, or other loose materials.
5. Application:	Carefully follow CSM's written instructions regarding mixing, thinning, application, recoat limitations (windows) and curing of coating materials.
6. System Thickness:	125 mils dry film.
7. Coatings:	
a. Primer:	Brush or roller apply at 6.0 – 10.0 mils DFT.
b. Broadcast Applied:	Brush or roller catalyzed resin and broadcast aggregate to rejection (should achieve 100 to 105 mils DFT).
c. Top:	Brush or roller apply at 8.0 – 10.0 mils.
	Install all termination and transition details in accordance with the CSM's detail drawings.
N. Coating System Identification: EF-2	
1. Coating Material:	Epoxy Resin Based Floor Coating
2. Surface:	Concrete Floors
3. Service Condition:	For interior – heavy-duty exposure applications. Frequent, heavy wheeled traffic and moderately corrosive exposure conditions. Mainly for wear resistance, impact resistance, protection of concrete, and aesthetics. Non-slip texture can be varied as needed. Test patches to be installed for deciding on level of non-slip texture required.
4. Surface Preparation:	Concrete floor slabs shall be allowed to age for at least 28 days and must meet a

	moisture vapor transmission rate of less than 3.0 lbs. of moisture per 24 hours per 1,000 SF in accordance with ASTM F1869. It is also essential that a well-sealed and intact vapor barrier has been installed beneath all slabs on grade to receive this floor coating system. Except as otherwise specified, loose concrete, curing compounds, and laitance shall be removed by abrasive blast cleaning or preferably by shotblasting. Surface preparation shall produce a clean sound concrete substrate with a concrete surface profile of CSP-7 minimum in accordance with ICRI 03732. Surface preparation shall be in accordance with SSPC-SP-13.
	Additionally, all coating termination and transition details shall be prepared in accordance with the CSM's standard detail drawings. This includes coating termination details, coating transitions at vertical and vertical to horizontal corners, coating terminations at joints, concrete crack treatment, pipe penetration treatment, coating terminations at metal embedments in the concrete substrate, and other details. The CSM's standard detail drawings shall be submitted for all such coating applications. If standard details are not available for a given detail treatment, the CSM shall be required to produce one at no additional cost to the owner, the engineer, or any other party.
	If wet abrasive or water blasting surface preparation methods were used, the concrete substrate shall be allowed to dry under warm conditions (minimum of 75 degrees F) for at least 5 days prior to coating application. Following surface preparation work and dry-out, all surfaces to be coated shall be vacuum cleaned to remove all loose dirt, dust, or other loose materials.
5. Application:	Carefully follow CSM's written instructions regarding mixing, thinning, application, recoat limitations (windows) and curing of coating materials.
6. System Thickness:	250 mils dry film.
7. Coatings:	
a. Primer:	Brush or roller apply at 6.0 – 10.0 mils DFT.
b. Trowel Applied:	Trowel apply to 230 – 236 mils.
c. Top:	Brush or roller apply at 8.0 – 10.0 mils. Cumulative dry film thickness.
	Install all termination and transition details in accordance with the CSM's detail drawings.
O. Coating System Identification: EA-1	
1. Coating Material:	Blended Amine Cured Epoxy
2. Surface:	Metal
3. Service Condition:	Immersed, nonpotable; non-immersed, corrosive environment, color not required especially for headspace environments that are corrosive due to biogenic sulfide corrosion.
4. Surface Preparation:	
a. Ferrous Metal:	Ferrous metal surfaces shall be prepared in accordance with SSPC SP-5 (White Metal Blast Cleaning) to achieve a uniform surface profile of 3.0 to 3.5 mils. Blast Cleaning shall produce a minimum surface profile of 3.0 mils.
	Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning surfaces in accordance with SSPC SP-11 (Power Tool Cleaning to Bare Metal). Damaged shop coated areas shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) and spot primed with the primer specified. Shop epoxy primed surfaces shall require light abrasive blasting and blow down cleaning prior to receiving finish coats. Cast or ductile iron surfaces to be coated shall be abrasive blast cleaned to a clean, gray uniform metal appearance free of variations in color and loose materials. Ductile iron surfaces shall be prepared in accordance with paragraph 3.02 Metallic Surfaces.
b. Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to achieve a uniform surface profile of 2.0 to 2.5 mils. Galvanized metal should generally not be used in these environments.
5. Application:	Field
a. General:	Prime coat may be thinned and applied as recommended by the CSM, provided the

	coating as applied complies with prevailing air pollution control regulations.
	Drying time between coats shall be as specified by the CSM for the site conditions. If the maximum recoat time is exceeded, surface preparation shall require solvent washing, light abrasive blasting, or other procedures per CSM's instructions.
b. Ferrous Metal:	If shop priming is required or field priming is necessary, the prime coat shall be an epoxy primer compatible with the specified coating system. Generally, the EA-1 coating system is self-priming and does not require a primer unless there is a special reason to prime the steel to hold the blast cleaning from rusting back.
6. System Thickness:	30 to 40 mils dry film.
7. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness only if required by special circumstances.
b. Finish:	One or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
c. Testing:	Holiday detection shall be performed over 100% of the coated surface area to identify any holidays or pinholes that must be repaired.
d. Pinhole and Holiday Repair Procedure:	Pinholes and holidays identified by Holiday Detection shall be repaired as follows:
	• Using a pencil grinder, remove a ½-inch diameter area of the coating system material back to the ferrous metal substrate. The metal must be shiny
	• Aggressively sand or abrade the intact coating system surface 2 inches around the complete periphery of the ½-inch diameter removal area to produce a uniform 6 to 8 mils profile
	• Vacuum clean the prepared area to remove all dust and dirt to achieve a clean, sound surface. Tape the peripheral area to prevent coating application onto unprepared surfaces
	• Brush apply one coat of the finish coating material. Following proper recoat cure time, apply additional coats of the finish coating system to achieve 60 mils DFT at the coating removal area and feather the coating onto the roughened coated surfaces to form a neat repair outline
P. Coating System Identification: EA-2	
1. Coating Material:	Blended Amine Cured Epoxy
2. Surface:	Concrete or masonry
3. Service Condition:	Immersed, nonpotable; non-immersed, corrosive environment, color not required, new construction especially for headspace environments that are corrosive due to biogenic sulfide corrosion.
4. Surface Preparation:	All coating termination and transition details shall be prepared in accordance with the CSM's standard detail drawings. This includes coating termination details, coating transitions at vertical and vertical to horizontal corners, coating terminations at joints, concrete crack treatment, pipe penetration treatment, coating terminations at metal embedments in the concrete substrate, and other details. The CSM's standard detail drawings shall be submitted for all such coating applications. If standard details are not available for a given detail treatment, the CSM shall be required to produce one at no additional cost to the owner, the engineer, or any other party.
	If wet abrasive or water blasting surface preparation methods were used, the concrete substrate shall be allowed to dry under warm conditions (minimum of 75 degrees F) for at least 5 days prior to coating application. Following surface preparation work and dry-out, all surfaces to be coated shall be vacuum cleaned to remove all loose dirt, dust, or other loose materials.
a. Concrete:	Concrete surfaces shall be allowed to cure for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Except as otherwise specified, loose concrete, form oils, surface hardeners, curing compounds, and laitance shall be removed from surfaces by abrasive blasting and chipping, and voids and cracks shall be repaired as specified in Section 03 30 00. Surface Preparation must open up all shelled over air voids or

	bugholes to expose fully the void's depth, width, and length. Concrete shall be abraded to achieve a uniform concrete surface profile of CSP-5 in accordance with ICRI 03732. After surface preparation has been accepted, a complete skim coat of the specified filler surfacer shall be applied over all concrete surfaces and all bugholes (air voids) shall be completely filled using this same material. The filler/surfacer material shall be applied as a complete parge coat of the substrate. If the parge coat (filler/surfacer material) is non-polymer modified, it must be brush blast cleaned following adequate cure per CSM's instructions to produce a uniform anchor pattern of CSP-4 in accordance with ICRI 03732 prior to coating application.
b. Masonry:	Masonry surfaces shall be allowed to cure for at least 28 days. Holes or other joint defects shall be filled with mortar and repointed and allowed to cure for 28 days or shall be filled with a repair material compatible with the coating system that does not require hydration cure time. Loose or splattered mortar shall be removed by scrapping and chipping.
	Masonry surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances.
	Muriatic acid shall not be used. After cleaning, masonry surfaces shall be skim coated with a surfacer or block filler compatible with the specified coating system.
5. Application:	Field
a. General:	Surfacer or filler shall be applied per CSM's recommendations prior to application of coating to fill all bugholes and voids and create a complete parge coat of the prepared substrate. This parge coat shall completely fill all bugholes and voids in the substrate, and will also completely cover the substrate unless specified otherwise above such filled voids by 1/8 inch (125 mils) of thickness. Drying time between coats shall be as specified by the CSM for the site conditions. If the maximum recoat time is exceeded, surface preparation shall require solvent washing, light abrasive blasting, or other procedures per CSM's instructions.
6. System Thickness:	60 mils dry film in addition to the parge coat.
7. Coatings:	
a. Finish:	One or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
b. Testing:	Holiday detection shall be performed over 100% of the coated surface area to identify any holidays or pinholes, which could compromise coating system performance. Holiday testing to be performed after application and adequate cure of the spray applied epoxy coating material. Holiday detection shall be performed in accordance with NACE RP0188.
c. Pinhole and Holiday Repair Procedure:	Pinholes and holidays identified by Holiday Detection shall be repaired as follows:
	• Using a grinder or other suitable power tool, remove the coating system at all pinholes or holidays in an area at least 2 inches in diameter or in both dimensions around the defect back to the concrete substrate.
	• Chip out and remove the concrete to expose the full dimensions in all three directions of the air void responsible for the defect.
	• Aggressively abrade or sand the intact coating system surface at least 3 inches beyond the removal area in all directions to produce a uniform 6- to 8-mil profile in the intact coating system.
	• Vacuum clean the prepared area to remove all dust, dirt, etc. leaving clean sound surfaces.
	• Tape to mask the periphery of the prepared intact coating area to prevent coating repair application onto the prepared area.
	• Using a putty knife or other suitable tool, fill the opened void with the approved filler/surfacer material completely and strike-off. Allow to cure per CSM's recommendations.
	• Apply the coating system in the number of coats necessary to achieve the specified 60 mils DFT over the defect and coating removal area and feather the coating onto the abraded coated surfaces around the removal area to avoid a lip and to achieve a neat repair outline. Allow to cure properly.

Coating System Specification Sheets (COATSPEC)

Q.	**Coating System Identification: EA-3**	
1.	Coating Material:	Blended Amine Cured Epoxy
2.	Surface:	Concrete or masonry
3.	Service Condition:	Immersed, nonpotable; non-immersed, corrosive environment, color not required, new or existing construction, especially for headspace environments that are corrosive due to biogenic sulfide corrosion.
4.	Surface Preparation:	All coating termination and transition details shall be prepared in accordance with the CSM's standard detail drawings. This includes coating termination details, coating transitions at vertical and vertical to horizontal corners, coating terminations at joints, concrete crack treatment, pipe penetration treatment, coating terminations at metal embedments in the concrete substrate, and other details. The CSM's standard detail drawings shall be submitted for all such coating applications. If standard details are not available for a given detail treatment, the CSM shall be required to produce one at no additional cost to the owner, the engineer, or any other party.
		If wet abrasive or water blasting surface preparation methods were used, the concrete substrate shall be allowed to dry under warm conditions (minimum of 75 degrees F) for at least 5 days prior to coating application. Following surface preparation work and dry-out, all surfaces to be coated shall be vacuum cleaned to remove all loose dirt, dust, or other loose materials.
a.	Concrete:	Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Except as otherwise specified, loose concrete, form oils, surface hardeners, curing compounds, and laitance shall be removed from surfaces by abrasive blasting and chipping, and voids and cracks shall be repaired as specified in Section 03 30 00. Concrete shall be abraded also to achieve a uniform concrete surface profile of CSP 5 minimum. If the parge coat (filler/surfacer material) is non-polymer modified, it shall be brush blasted following adequate cure per the CSM's instructions to produce a uniform concrete surface profile of CSP-4 in accordance with ICRI 03732 prior to coating application. After cleaning, air voids or bugholes in the concrete shall be filled with a surfacer or block filler. The filler/surfacer material shall be applied as a complete parge coat of the substrate.
		For existing concrete that has been degraded, apply a skim coat of a surfacer or filler material to restore the substrate to a coatable condition. Be certain the filler surfacer material is compatible with the coating system.
b.	Masonry:	Masonry surfaces shall be allowed to age for at least 28 days. Holes or other joint defects shall be filled with mortar and repointed. Loose or splattered mortar shall be removed by scrapping and chipping.
		Masonry surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances.
		Muriatic acid shall not be used. After cleaning, masonry surfaces shall be sealed or filled with sealer or block filler compatible with the specified coating system.
5.	Application:	Field
a.	General:	Surfacer or filler shall be applied and dry per CSM's recommendations prior to application of coating.
		Drying time between filler/surfacer and coating system shall be as specified by the CSM for the site conditions. If the maximum recoat time is exceeded, surface preparation shall require solvent washing, light abrasive blasting, or other procedures per CSM's instructions. The parge coat shall completely fill all bugholes and voids in the substrate and it will also completely cover the substrate unless specified otherwise above such filled voids by 1/8 inch of thickness.
6.	System Thickness:	125 mils dry film (or 1/8 inch) in addition to the parge coat.
7.	Coatings:	
a.	Primer:	Self-priming.

b. Finish:	One coat at CSM's recommended dry film thickness – trowel applied.
c. Testing:	Holiday detection shall be performed over 100% of the coated surface area to identify any holidays or pinholes that could compromise coating system performance. Holiday detection shall be performed after adequate cure of the spray applied epoxy coating material. Holiday detection shall be performed in accordance with NACE RP0188.
d. Pinhole and Holiday Repair Procedure:	Pinholes and holidays identified by Holiday Detection shall be repaired as follows:
	• Using a grinder or other suitable power tool, remove the coating system at all pinholes or holidays in an area at least 2 inches in diameter or in both dimensions around the defect back to the concrete substrate.
	• Chip out and remove the concrete to expose the full dimensions in all three directions of the air void responsible for the defect.
	• Aggressively abrade or sand the intact coating system surface at least 3-inches beyond the removal area in all directions to produce a uniform 6- to 8-mil profile in the intact coating system.
	• Vacuum clean the prepared area to remove all dust, dirt, etc. leaving clean sound surfaces.
	• Tape to mask the periphery of the prepared intact coating area to prevent coating repair application onto the prepared area.
	• Using a putty knife or other suitable tool, fill the opened void with the approved filler/surfacer material completely and strike-off. Allow to cure per CSM's recommendations.
	• Apply the coating system in the number of coats necessary to achieve the specified 60 mils DFT over the defect and coating removal area and feather the coating onto the abraded coated surfaces around the removal area to avoid a lip and to achieve a neat repair outline. Allow to cure properly.
R. Coating System Identification: EA-4	
1. Coating Material:	Blended Amine Cured Epoxy
2. Surface:	Concrete or masonry
3. Service Condition:	Immersed, nonpotable; non-immersed, very corrosive environment, color not required, new or existing construction, especially for headspace environments that are very corrosive due to biogenic sulfide corrosion.
4. Surface Preparation:	All coating termination and transition details shall be prepared in accordance with the CSM's standard detail drawings. This includes coating termination details, coating transitions at vertical and vertical to horizontal corners, coating terminations at joints, concrete crack treatment, pipe penetration treatment, coating terminations at metal embedments in the concrete substrate, and other details. The CSM's standard detail drawings shall be submitted for all such coating applications. If standard details are not available for a given detail treatment, the CSM shall be required to produce one at no additional cost to the owner, the engineer, or any other party.
	If wet abrasive or water blasting surface preparation methods were used, the concrete substrate shall be allowed to dry under warm conditions (minimum of 75 degrees F) for at least 5 days prior to coating application. Following surface preparation work and dry-out, all surfaces to be coated shall be vacuum cleaned to remove all loose dirt, dust, or other loose materials.
a. Concrete:	Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Except as otherwise specified, loose concrete, form oils, surface hardeners, curing compounds, and laitance shall be removed from surfaces by abrasive blasting and chipping, and voids and cracks shall be repaired as specified in Section 03 30 00. Concrete shall be abraded also to achieve a uniform concrete surface profile of CSP 5 minimum. If the parge coat (filler/surfacer material) is non-polymer modified, it shall be brush blasted following adequate cure per the CSM's instructions to produce a uniform concrete surface profile of CSP-4 in accordance with ICRI 03732 prior to coating application. After cleaning, air voids or bugholes in

	the concrete shall be filled with a surfacer or block filler. The filler/surfacer material shall be applied as a complete parge coat of the substrate.
	For existing concrete that has been degraded, apply a skim coat of a surfacer or filler material to restore the substrate to a coatable condition. Be certain the filler surfacer material is compatible with the coating system.
b. Masonry:	Masonry surfaces shall be allowed to age for at least 28 days. Holes or other joint defects shall be filled with mortar and repointed. Loose or splattered mortar shall be removed by scrapping and chipping.
	Masonry surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances.
	Muriatic acid shall not be used. After cleaning, masonry surfaces shall be sealed or filled with sealer or block filler compatible with the specified coating system.
5. Application:	Field
a. General:	Surfacer or filler shall be applied and dry per CSM's recommendations prior to application of coating.
	Drying time between filler/surfacer and coating system shall be as specified by the CSM for the site conditions. If the maximum recoat time is exceeded, surface preparation shall require solvent washing, light abrasive blasting, or other procedures per CSM's instructions. The parge coat shall completely fill all bugholes and voids in the substrate and it will also completely cover the substrate unless specified otherwise above such filled voids by 1/8 inch of thickness.
6. System Thickness:	140 to 145 mils dry film in addition to the parge coat.
7. Coatings:	
a. Primer:	Self-priming.
b. Troweled Coat:	One coat at CSM's recommended dry film thickness – trowel applied. (125 mils)
c. Finish (Glaze Coat):	15 to 20 mils dry.
d. Testing:	Holiday detection shall be performed over 100% of the coated surface area to identify any holidays or pinholes that could compromise coating system performance. Holiday detection shall be performed after application and adequate cure of the spray applied epoxy coating material. Holiday detection shall be performed in accordance with NACE RP0188.
e. Pinhole and Holiday Repair Procedure:	Pinholes and holidays identified by Holiday Detection shall be repaired as follows:
	• Using a grinder or other suitable power tool, remove the coating system at all pinholes or holidays in an area at least 2 inches in diameter or in both dimensions around the defect back to the concrete substrate
	• Chip out and remove the concrete to expose the full dimensions in all three directions of the air void responsible for the defect.
	• Aggressively abrade or sand the intact coating system surface at least 3-inches beyond the removal area in all directions to produce a uniform 6- to 8-mil profile in the intact coating system.
	• Vacuum clean the prepared area to remove all dust, dirt, etc. leaving clean sound surfaces.
	• Tape to mask the periphery of the prepared intact coating area to prevent coating repair application onto the prepared area.
	• Using a putty knife or other suitable tool, fill the opened void with the approved filler/surfacer material completely and strike-off. Allow to cure per CSM's recommendations
	• Apply the coating system in the number of coats necessary to achieve the specified 60 mils DFT over the defect and coating removal area and feather the coating onto the abraded coated surfaces around the removal area to avoid a lip and to achieve a neat repair outline. Allow to cure properly.
S. Coating System Identification: EA-5	
1. Coating Material:	Novolac Epoxy Lining
2. Surface:	Concrete or masonry
3. Service Condition:	Chemical area process slabs, chemical loading and unloading areas, secondary spill

	containment areas for ferric chloride or 25% hydrofluoro-silicic acid.
4. Surface Preparation:	All coating termination and transition details shall be prepared in accordance with the CSM's standard detail drawings. This includes coating termination details, coating transitions at vertical and vertical to horizontal corners, coating terminations at joints, concrete crack treatment, pipe penetration treatment, coating terminations at metal embedments in the concrete substrate, and other details. The CSM's standard detail drawings shall be submitted for all such coating applications. If standard details are not available for a given detail treatment, the CSM shall be required to produce one at no additional cost to the owner, the engineer, or any other party.
	If wet abrasive or water blasting surface preparation methods were used, the concrete substrate shall be allowed to dry under warm conditions (minimum of 75 degrees F) for at least 5 days prior to coating application. Following surface preparation work and dry-out, all surfaces to be coated shall be vacuum cleaned to remove all loose dirt, dust, or other loose materials.
a. Concrete:	Concrete surfaces shall be allowed to cure for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Except as otherwise specified, loose concrete, form oils, surface hardeners, curing compounds, and laitance shall be removed from surfaces by abrasive blasting and chipping, and voids and cracks shall be repaired as specified in Section 03 30 00. Surface Preparation must open up all shelled over air voids or bugholes to expose fully the void's depth, width, and length. Concrete shall be abraded to achieve a uniform concrete surface profile of CSP-5 in accordance with ICRI 03732. After surface preparation has been accepted, a complete skim coat of the specified filler surfacer shall be applied over all concrete surfaces and all bugholes (air voids) shall be completely filled using this same material. The filler/surfacer material shall be applied as a complete parge coat of the substrate. If the parge coat (filler/surfacer material) is non-polymer modified, it must be brush blast cleaned following adequate cure per CSM's instructions to produce a uniform anchor pattern of CSP-4 in accordance with ICRI 03732 prior to coating application.
5. Application:	Field
a. General:	Prime coat shall be applied as recommended by the CSM.
	Surfacers or filler materials shall be trowel applied per CSM's recommendations. Work surfacer/filler into all voids to displace air and fill bugholes.
	Surfacer/filler and prime coat thicknesses are in addition to the system thickness specified below.
6. System Thickness:	

Location	System Thickness (mils dry film)
[FECL Receiving Station	
Slab	110-145 (with silica sand)
Sump walls and floor	40
Storage Tank Secondary Containment	
Floor and other horizontal surfaces	60-75
Vertical Surfaces	40
Metering Pump Secondary Containment	
Floor and other horizontal surfaces	60-75 (with silica sand)
Vertical Surfaces	40]

7. Coatings:	
a. Primer:	As recommended by the CSM.
b. Surfacer/Filler:	1/16-inch minimum thickness above plane of concrete to create a monolithic and pinhole free surface.

	Surfacer or filler shall be applied per CSM's recommendations prior to application of coating system to fill all bugholes and voids and create a coatable surface by being applied as a complete 1/8 inch thick parge coat. This is for containment walls, curbs and bases and not for floor surfaces.
c. Base Coat Floor Surfaces:	For floor surfaces, the base coat shall be applied at thickness recommended by CSM and broadcast with aggregate to create a non-slip surface (texture to be as recommended by the CSM). Following application of the broadcast aggregate and removal of all excess aggregates, the base coat will be applied to encapsulate the non-slip aggregate embedded.
d. Base Coat and Saturation Coat:	For trench or sump surfaces and unloading areas, the base coat shall be applied to the thickness recommended by the CSM and then scrim cloth shall be embedded in it. Next, the same material will be applied as a saturation coat to encapsulate fully the scrim cloth. This shall be applied to the thickness recommended by the CSM.
e. Base Coat for Containment Wall and Base Surfaces:	For containment wall, curb, and equipment base surfaces shall be applied to the thickness recommended by the CSM.
f. Base Coat General:	The basecoat will be an aggregate filled coating as will the saturation coat. Both shall be applied in strict accordance with the CSM's recommendations. The aggregate used in these coating systems for hydrofluorosilica aggregates resistant to the HFS or fully encapsulated with resin to prevent attack of the silica aggregate.
g. Finish:	The finish coat or coats shall be applied to the thickness recommended by the CSM.
	All coating system thicknesses are in addition to the parge coat.
h. Testing:	Holiday detection shall be performed over 100% of the coated surface area to identify any holidays or pinholes that must be repaired. Holiday detection to be performed after proper application and cure of the coating system. Holiday detection to be performed in accordance with NACE RP0188.
i. Pinhole and Holiday Repair Procedure:	Pinholes or holidays identified by Holiday Detection shall be repaired as follows:
	• Using a grinder or other suitable power tool, remove the coating system at all pinholes or holidays in an area at least 2 inches in diameter or in both dimensions around the defect back to the concrete substrate.
	• Chip out and remove the concrete to expose the full dimensions in all three directions of the air void responsible for the defect.
	• Aggressively abrade or sand the intact coating system surface at least 3 inches beyond the removal area in all directions to produce a uniform 6- to 8-mil profile in the intact coating system.
	• Vacuum clean the prepared area to remove all dust, dirt, etc. leaving clean sound surfaces.
	• Tape to mask the periphery of the prepared intact coating area to prevent coating repair application onto the prepared area.
	• Using a putty knife or other suitable tool, fill the opened void with the approved filler/surfacer material completely and strike-off. Allow to cure per CSM's recommendations.
	• Apply the coating system in the number of coats necessary to achieve the specified finish coat thickness over the defect and coating removal area and feather the coating onto the abraded coated surfaces around the removal area to avoid a lip and to achieve a neat repair outline. Allow to cure properly.
	• Curing time between coats shall be as specified by the CSM for the site conditions. If the maximum recoat time is exceeded, surface preparation shall require solvent washing, light abrasive blasting, or other procedures per CSM's instructions.
T. Coating System Identification: EC-1	
1. Coating Material:	Hybrid Polyurethane
2. Surface:	Concrete or dense masonry where existing crack or joint movement is suspected of propagating through rigid cured epoxy coatings.
3. Service Condition:	Interior or exterior, exposed to direct sunlight or not, corrosive (immersion pH 4.0 or lower and/or headspace pH 4.0 or lower and/or gaseous H_2S concentrations

	between 10 and 150 ppm typically).
4. Surface Preparation:	All coating termination and transition details shall be prepared in accordance with the CSM's standard detail drawings. This includes coating termination details, coating transitions at vertical and vertical to horizontal corners, coating terminations at joints, concrete crack treatment, pipe penetration treatment, coating terminations at metal embedments in the concrete substrate, and other details. The CSM's standard detail drawings shall be submitted for all such coating applications. If standard details are not available for a given detail treatment, the CSM shall be required to produce one at no additional cost to the owner, the engineer, or any other party.
	If wet abrasive or water blasting surface preparation methods were used, the concrete substrate shall be allowed to dry under warm conditions (minimum of 75 degrees F) for at least 5 days prior to coating application. Following surface preparation work and dry-out, all surfaces to be coated shall be vacuum cleaned to remove all loose dirt, dust, or other loose materials.
a. Concrete:	Concrete surfaces shall be allowed to cure for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Except as otherwise specified, loose concrete, form oils, surface hardeners, curing compounds, and laitance shall be removed from surfaces by abrasive blasting and chipping, and voids and cracks shall be repaired as specified in Section 03 30 00. Surface Preparation must open up all shelled over air voids or bugholes to expose fully the void's depth, width, and length. Concrete shall be abraded to achieve a uniform concrete surface profile of CSP-5 in accordance with ICRI 03732. After surface preparation has been accepted, a complete skim coat of the specified filler surfacer shall be applied over all concrete surfaces and all bugholes (air voids) shall be completely filled using this same material. The filler/surfacer material shall be applied as a complete parge coat of the substrate. If the parge coat (filler/surfacer material) is non-polymer modified, it must be brush blast cleaned following adequate cure per CSM's instructions to produce a uniform anchor pattern of CSP-4 in accordance with ICRI 03732 prior to coating application.
5. Application:	Field
a. General:	Surfacers or filler materials shall be applied per CSM's recommendations prior to application of prime coat to fill bugholes and voids. These materials must be compatible with the primers and finish coats.
	Prime coat shall be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.
6. System Thickness:	35-50 mils dry film in addition to the parge coat.
7. Coatings:	
a. Primer:	One coat at 2-3 mils dry film thickness
b. Finish:	One or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
c. Testing:	Holiday detection shall be performed over 100% of the coated surface area to identify any holidays or pinholes that must be repaired.
d. Pinhole and Holiday Repair Procedure:	Pinholes or holidays identified by Holiday Detection shall be repaired as follows:
	• Using a grinder or other suitable power tool, remove the coating system at all pinholes or holidays in an area at least 2 inches in diameter or in both dimensions around the defect back to the concrete substrate.
	• Chip out and remove the concrete to expose the full dimensions in all three directions of the air void responsible for the defect.
	• Aggressively abrade or sand the intact coating system surface at least 3-inches beyond the removal area in all directions to produce a uniform 6- to 8-mil profile in the intact coating system.
	• Vacuum clean the prepared area to remove all dust, dirt, etc. leaving clean sound surfaces
	• Tape to mask the periphery of the prepared intact coating area to prevent coating repair application onto the prepared area

	• Using a putty knife or other suitable tool, fill the opened void with the approved filler/surfacer material completely and strike-off. Allow to cure per CSM's recommendations
	• Apply the coating system in the number of coats necessary to achieve the specified 35-50 mils DFT over the defect and coating removal area and feather the coating onto the abraded coated surfaces around the removal area to avoid a lip and to achieve a neat repair outline. Allow to cure properly.
U. Coating System Identification: EC-2 (NSF-61)	
1. Coating Material:	Modified Polyurethane
2. Surface:	Concrete or Dense Masonry where existing crack or joint movement is suspected due to thermal conditions and would propagate through rigid epoxy coating systems and/or where NSF-61 certification is required.
3. Service Condition:	Interior or exterior, submerged or non-submerged indirect sunlight – moderately corrosive.
4. Surface Preparation:	All coating termination and transition details shall be prepared in accordance with the CSM's standard detail drawings. This includes coating termination details, coating transitions at vertical and vertical to horizontal corners, coating terminations at joints, concrete crack treatment, pipe penetration treatment, coating terminations at metal embedments in the concrete substrate, and other details. The CSM's standard detail drawings shall be submitted for all such coating applications. If standard details are not available for a given detail treatment, the CSM shall be required to produce one at no additional cost to the owner, the engineer, or any other party.
	If wet abrasive or water blasting surface preparation methods were used, the concrete substrate shall be allowed to dry under warm conditions (minimum of 75 degrees F) for at least 5 days prior to coating application. Following surface preparation work and dry-out, all surfaces to be coated shall be vacuum cleaned to remove all loose dirt, dust, or other loose materials.
a. Concrete:	Concrete surfaces shall be allowed to cure for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Except as otherwise specified, loose concrete, form oils, surface hardeners, curing compounds, and laitance shall be removed from surfaces by abrasive blasting and chipping, and voids and cracks shall be repaired as specified in Section 03 30 00. Surface Preparation must open up all shelled over air voids or bugholes to expose fully the void's depth, width, and length. Concrete shall be abraded to achieve a uniform concrete surface profile of CSP-5 in accordance with ICRI 03732. After surface preparation has been accepted, a complete skim coat of the specified filler surfacer shall be applied over all concrete surfaces and all bugholes (air voids) shall be completely filled using this same material. The filler/surfacer material shall be applied as a complete parge coat of the substrate. If the parge coat (filler/surfacer material) is non-polymer modified, it must be brush blast cleaned following adequate cure per CSM's instructions to produce a uniform anchor pattern of CSP-4 in accordance with ICRI 03732 prior to coating application.
5. Application:	Field
a. General:	Surfacer or filler shall be applied per CSM's recommendations prior to application of prime coat to fill bugholes and voids. These materials must be compatible with the primers and finish coats.
	Prime coat shall be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.
6. System Thickness:	50-75 mils dry film.
7. Coatings:	
a. Primer:	One coat at 3-5 mils dry film thickness
b. Finish:	One or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
c. Testing:	Holiday detection shall be performed over 100% of the coated surface area to

	identify any holidays or pinholes that must be repaired.
d. Pinhole and Holiday Repair Procedure:	Pinholes or holidays identified by Holiday Detection shall be repaired as follows:
	• Using a grinder or other suitable power tool, remove the coating system at all pinholes or holidays in an area at least 2 inches in diameter or in both dimensions around the defect back to the concrete substrate.
	• Chip out and remove the concrete to expose the full dimensions in all three directions of the air void responsible for the defect.
	• Aggressively abrade or sand the intact coating system surface at least 3-inches beyond the removal area in all directions to produce a uniform 6- to 8-mil profile in the intact coating system.
	• Vacuum clean the prepared area to remove all dust, dirt, etc. leaving clean sound surfaces.
	• Tape to mask the periphery of the prepared intact coating area to prevent coating repair application onto the prepared area.
	• Using a putty knife or other suitable tool, fill the opened void with the approved filler/surfacer material completely and strike-off. Allow to cure per CSM's recommendations.
	• Apply the coating system in the number of coats necessary to achieve the specified 35-50 mils DFT over the defect and coating removal area and feather the coating onto the abraded coated surfaces around the removal area to avoid a lip and to achieve a neat repair outline. Allow to cure properly.
V. Coating System Identification: EU-1	
1. Coating Material:	Zinc-Epoxy-Polyurethane System
2. Surface:	Ferrous Metal
3. Service Condition:	Exterior, exposed to direct sunlight, moderately corrosive, non-immersed.
4. Surface Preparation:	
a. General:	Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning surfaces in accordance with SSPC SP-2 (Hand Tool Cleaning). Damaged shop coated areas shall be cleaned in accordance with SSPC SP-3 (Power Tool Cleaning) and recoated with the primer specified.
b. Ferrous Metal:	Bare ferrous metal surfaces shall be prepared in accordance with SSPC SP-6 (Commercial Blast Cleaning) 2.5 – 3.0. Ductile iron surfaces to be coated shall be abrasive blast cleaned in accordance with paragraph 3.02 Metallic Surfaces.
	Ferrous metal with rust bleeding shall be cleaned in accordance with SSPC-SP-11 (Power Tool Cleaning to Bare Metal). Areas of rust penetration shall be spot blasted to SSPC SP-10 (Near White Blast) and spot primed with the specified primer.
c. Galvanized Metal:	Damaged galvanized steel areas with exposed ferrous metal and/or rusted shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) or Power Tool Cleaned to Bare Metal in accordance with SSPC-SP-11 to achieve a uniform 1.0- to 1.5-mil profile and spot primed with the primer specified.
	Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to impart a 1.0- to 2.0-mil profile to the galvanized steel surfaces. Where this cannot be performed, prepare by abrading in accordance with SSPC-SP-3, Power Tool Cleaning to impart a 1.0- to 1.5-mil profile uniformly to the galvanized steel surfaces.
	For EU-1 over galvanized steel, delete the zinc rich primer.
5. Application:	Field
a. General:	Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.
b. Ferrous Metal:	Prime coats shall be a zinc rich epoxy or polyurethane primer compatible for use with urethane finish coats and applied in accordance with written instructions of the CSM or in the case of CARB or SCAQMD applications, prime with specified primer that is not zinc rich. In these cases, only a two-coat system is applied.
6. System Thickness:	3 to 4 mils of zinc rich primer, one intermediate or primer epoxy coat at 5 to 6 mils

	and one finish coat of polyurethane at 2 to 3 mils DFT.
7. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Intermediate:	One coat at CSM's recommended dry film thickness.
c. Finish:	One coat at CSM's recommended dry film thickness per coat to meet the specified system thickness.
W. Coating System Identification: EU-1-FRP	
1. Coating Material:	Specialty Primer plus Polyurethane Finish Coat
2. Surface:	Exterior of FRP Pipe and Tanks, etc.
3. Service Condition:	Exterior, exposed to direct sunlight, non-immersed.
4. Surface Preparation:	
a. General:	Clean to remove loose dirt, dust, or other contaminants.
	Prepare surfaces by sanding to produce roughness to achieve a uniform, minimum surface profile of 1.5 to 2.0 mils.
	Solvent clean thoroughly using solvent as recommended by the CSM.
	Thoroughly clean to remove loose debris by vacuum cleaning.
5. Application:	Field
a. General:	Apply primer coat and thin as recommended by the CSM provided the coating applied complies with prevailing air pollution control regulations.
	Apply finish coat as recommended by the CSM.
6. System Thickness:	Primer to 2 to 4 mils and finish coat is 2 to 3 mils DFT.
7. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Finish:	One coat at CSM's recommended dry film thickness per coat to meet the specified system thickness.
X. Coating System Identification: G	
1. Coating Material:	Grease
2. Surface:	Metal
3. Surface Preparation:	
a. Ferrous Metal:	Ferrous metal surfaces shall be prepared in accordance with SSPC SP-1 (Solvent Cleaning).
4. Application:	Field
	Coating shall be applied with stiff brush, hand swab, or airless spray gun.
5. System Thickness:	50 square feet per gallon
6. Coating:	One coat of grease coating.
Y. Coating System Identification: HH-1	
1. Coating Material:	Proprietary Primer plus Silicone Topcoat
2. Surface:	Metal
3. Service Condition:	Temperature to 750 degrees F.
4. Surface Preparation:	Metal surfaces shall be prepared in accordance with SSPC SP-10 (Near White Metal Blast Cleaning) to achieve a uniform surface profile of 2.0 to 2.5 mils.
5. Application:	Field
	Curing as required by CSM.
6. System Thickness:	6.5 to 8.0 mils dry film
7. Coating:	Primer at 5 to 6 mils DFT plus one topcoat at 1.5 to 2.0 mils DFT.
Z. Coating System Identification: HH-2	
1. Coating Material:	Proprietary Primer plus Silicone Topcoat (available in black or aluminum only)

2. Surface:	Metal
3. Service Condition:	Temperature to 1200 degrees F.
4. Surface Preparation:	Metal surfaces shall be prepared in accordance with SSPC SP-10 (Near White Metal Blast Cleaning) to achieve a uniform surface profile of 2.0 to 2.5 mils.
5. Application:	Field
	Curing as required by CSM.
6. System Thickness:	6.5 to 8.0 mils dry film
7. Coating:	Primer at 5 to 6 mils DFT plus one topcoat at 1.5 to 2.0 mils DFT.
AA. Coating System Identification: L-1	
1. Coating Material:	Latex
2. Surfaces:	Concrete, masonry, plaster, gypsum board.
3. Service Condition:	Interior and exterior including existing exterior coated concrete.
4. Surface Preparation:	
a. Concrete:	Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Loose concrete and laitance shall be removed from surfaces, and voids and cracks shall be repaired as specified in Section 03 30 00.
b. Existing Coated Concrete:	Remove all loose coating down to a sound substrate or intact, well-adhered existing coating by scraping or other means. Then, abrade all surfaces to achieve a 0.5- to 1.5-mil uniform profile and vacuum clean to remove all loose dirt, paint chips, and dirt.
c. Masonry:	Masonry surfaces shall be allowed to age for at least 28 days. Holes or other joint defects shall be filled with mortar and repointed. Loose or splattered mortar shall be removed by scraping and chipping. Masonry surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances. Muriatic acid shall not be used. After cleaning, masonry surfaces shall be filled with block filler compatible with the specified primer.
d. Plaster:	Plaster surfaces shall be dry, clean, and free from grit, loose plaster, and surface irregularities. Cracks and holes shall be repaired with acceptable patching materials, keyed to existing surfaces, and sandpapered smooth. Surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances. After cleaning, surfaces shall be sealed with a compatible sealer.
e. Gypsum Wallboard:	Tape joints and spackled nail heads shall be sanded smooth and dusted. Seal with PVA sealer for interior uses only.
5. Application:	Field
a. General:	Sealer or filler shall dry a minimum of 48 hours prior to primer application.
	Drying time between coats shall be as recommended by CSM.
6. System Thickness:	4 mils dry film.
7. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Finish:	Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
BB. Coating System Identification: L-2	
1. Coating Material:	Latex
2. Surface:	PVC and CPVC pipe.
3. Service Condition:	Exterior, direct sunlight exposure.
4. Surface Preparation:	Plastic pipe shall be cleaned with solvent compatible with the specified primer and sanded to roughen surfaces to achieve a uniform surface profile of 1.0 to 1.5 mils. Vacuum clean after sanding to remove all loose dust, plastic particles, and dirt.

5. Application:	Field
6. System Thickness:	3 mils dry film.
7. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Finish:	One or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
CC. Coating System Identification: L-3	
1. Coating Material:	Latex – Direct to Metal
2. Surface:	Ferrous Metal
3. Service Condition:	Interior or Exterior
4. Surface Preparation:	
a. Ferrous Metals:	Bare ferrous metal surfaces shall be prepared in accordance with SSPC SP-6 (Commercial Blast Cleaning) unless specified otherwise. Impart a 1.5- to 2.0-mil profile to substrate.
	Ferrous metal with rust bleeding shall be cleaned in accordance with SSPC SP-1 (Solvent Cleaning). Areas of rust penetration shall be spot blasted to SSPC SP-10 (Near White Blast) and spot primed with the specified primer.
	Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning surfaces in accordance with SSPC SP-2 (Hand Tool Cleaning) or SSPC-SP-3 (Power Tool Cleaning).
b. Nonferrous and Galvanized Metal:	Galvanized or nonferrous surfaces shall be prepared in accordance with SSPC SP-1 (Solvent Cleaning) after Brush Blast Cleaning in accordance with SSPC-SP-7.
5. Application:	Field
6. System Thickness:	6 to 8 mils dry film excluding sealer
7. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Finish:	Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
DD. Coating System Identification: L-4	
1. Coating Material:	Latex
2. Surface:	Wood
3. Service Condition:	Interior
4. Surface Preparation:	Wood surfaces shall be cleaned of dirt, oil or other foreign substances with mineral spirits, scrapers, sandpaper or wire brush. Finished surfaces exposed to view shall be smoothed by planing or sandpapering. Millwork shall be sandpapered and given a coat of the specified primer on all sides before installation. Built-in surfaces of windowsills shall be double primed. Glazing rabbets and beads in exterior sash and doors shall be double primed. Small, dry, seasoned knots shall be surfaced scraped, sandpapered, and thoroughly cleaned and shall be given a thin coat of an acceptable knot sealer before application of the priming coat. Large, open, unseasoned knots, and beads or streaks of pitch shall be scraped off; however, if the pitch is still soft, it shall be removed with mineral spirits or turpentine, and the resinous area shall be coated with knot sealer prior to priming. After priming, holes and imperfections shall be filled with putty or plastic wood, colored to match the finish coat, allowed to dry and sandpapered smooth.
5. Application:	Field
6. System Thickness:	4.0 mils dry film.
7. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Finish:	Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.

Coating System Specification Sheets (COATSPEC)

EE.	**Coating System Identification: M-1**	
1.	Coating Material:	Petrolatum based mastic or wax based wrapping tapes.
2.	Surfaces:	Metal
3.	Service Condition:	Below grade (buried) or where little to no surface preparation can be performed on piping or structural steel.
4.	Surface Preparation:	Remove loose scale, rust, dirt, excessive moisture, or frost from the surface in accordance with SSPC SP-2 (Hand Tool Cleaning).
5.	Application:	All surfaces shall be hand rubbed or brushed with a priming paste recommended by the CSM. Sharp projections such as threads, irregular contours, or badly pitted areas shall receive a liberal amount of priming paste to ensure maximum protection of metal throughout.
		On irregular shaped surfaces, i.e., nuts, bolts, flanges, valves, etc., the Contractor shall use either of the following systems recommended by the CSM.
		A. Apply recommended mastic by hand in sufficient quantity to build an even contour over entire surface. The Contractor shall pay particular attention to ensure that folds and air pockets within the mastic layer are thoroughly pressed out prior to subsequent application of tape.
		OR:
		B. An extra layer of tape shall be cut and carefully molded around sharp projections, nuts, bolts, etc., before final application of tape, in order to meet specified system thickness.
		Tape shall be spirally wrapped with a 55 percent overlap and sufficient tension and pressure to provide continuous adhesion without stretching the tape. Edges of tape must be continuously smoothed and sealed by hand during wrapping. On vertical application, contractor shall begin at bottom and proceed upward creating a weatherboard overlap.
6.	System Thickness:	Smooth contours shall have a minimum thickness of 50 mils while nuts, bolts, and sharp projections shall be 100 mils.
7.	Tape:	Number and types of tape wraps shall be in accordance with the CSM's written instructions.
FF.	**Coating System Identification: M-2**	
1.	Coating Material:	Epoxy mastic or equal
2.	Surface:	Ferrous Metal
3.	Service Condition:	Interior, corrosive environment, confined enclosures, where minimal surface preparation is possible.
4.	Surface Preparation:	
	a. Ferrous Metal:	All uncoated ferrous metal surfaces shall be prepared in accordance with SSPC SP-3 (Power Tool Cleaning), or SSPC-SP-11 (Power to Cleaning to Bare Metal) prior to assembly. Surface preparation to achieve a uniform surface profile of 2.0 to 2.5 mils. Shop primed ferrous metal surfaces and fabricated assemblies shall be clean and dry prior to the application of field coats. Following assembly, the Contractor shall smooth welds and prominences using power tools prior to the application of the field applied coatings.
5.	Application:	Field
	a. General:	Prior to the application of field applied coatings, welds, back-to-back angles, sharp or rough edges and weld splatter shall be brushed with the specified prime coat and allowed to cure overnight.
6.	System Thickness:	15 mils dry film.
7.	Coatings:	
	a. Prime:	One coat of the CSM’s recommended dry film thickness.
	b. Finish:	One or more coats of CSM’s recommended dry film thickness per coat to the specified system thickness.

Coating System Specification Sheets (COATSPEC)

GG. Coating System Identification: S-1	
1. Coating Material:	Penetrating acrylic stain, color required.
2. Surface:	Concrete
3. Service Condition:	Non-immersed, exposure to moisture and sunlight.
4. Surface Preparation:	Brush-off blast or industry standard acid etch or other preparation as approved by the CSM.
5. Application:	
a. General:	Drying time between coats shall be as specified by the CSM for the site conditions.
b. Coatings:	Minimum of two coats overall (coat as many times as required to achieve desired color).
6. System Thickness:	200 square feet per gallon maximum or as recommended by the CSM.
7. Color Selection:	As approved by the Construction Manager consistent with neighborhood selection. The Contractor to price materials based on custom color.
HH. Coating System Identification: S-2	
1. Coating Material:	Penetrating Water Repellent (Clear and Non-Film Building)
2. Surface:	Concrete Floors
3. Service Condition:	Exterior and Interior.
4. Surface Preparation:	Clean surfaces of all traces of dirt, dust, efflorescence, mold, salt, grease, oil, asphalt, laitance, curing compounds, paint, coatings, and other foreign materials by brush-off blast, water blasting, and/or chemical cleaners or other preparation as approved by the CSM.
a. Concrete	Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Loose concrete and laitance shall be removed from surfaces, and voids and cracks shall be repaired as specified in Section 03 30 00.
5. Application:	
a. General:	Drying time before placing into service shall be as recommended by the CSM for site conditions.
6. System Coverage:	Follow CSM's recommendations.
7. Color Selection:	Clear.
II. Coating System Identification: S-3	
1. Coating Material:	Penetrating Water Repellent (Clear & Non-Film Building)
2. Surface:	Concrete and Masonry Walls
3. Service Condition:	Exterior and Interior – For Anti-Graffiti Applications
4. Surface Preparation:	Clean surfaces of all traces of dirt, dust, efflorescence, mold, salt, grease, oil, asphalt, laitance, curing compounds, paint, coatings, and other foreign materials by brush-off blast, water blasting, and/or chemical cleaners or other preparation as approved by the CSM.
a. Concrete	Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Loose concrete and laitance shall be removed from surfaces, and voids and cracks shall be repaired as specified in Section 03 30 00.
b. Masonry:	Masonry surfaces shall be allowed to age for at least 28 days. Holes or other joint defects shall be filled with mortar and repointed. Loose or splattered mortar shall be removed by scraping and chipping. Masonry surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances. Muriatic acid shall not be used.
5. Application:	
a. General:	Drying time before placing into service shall be as recommended by the CSM for

	site conditions.
6. System Coverage:	Follow CSM's recommendations.
7. Color Selection:	Clear.
JJ. Coating System Identification: S-4	
1. Coating Material:	Penetrating Oil and Water Repellent (Non-Film Forming)
2. Surface:	Concrete Floors
3. Service Condition:	Exterior and Interior
4. Surface Preparation:	Clean surfaces of all traces of dirt, dust, efflorescence, mold, salt, grease, oil, asphalt, laitance, curing compounds, paint, coatings, and other foreign materials by brush-off blast, water blasting, and/or chemical cleaners or other preparation as approved by the CSM.
a. Concrete	Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Loose concrete and laitance shall be removed from surfaces, and voids and cracks shall be repaired as specified in Section 03 30 00.
5. Application:	
a. General:	Drying time before placing into service shall be as recommended by the CSM for site conditions.
b. Coatings:	One coat, flood horizontal surface so coating ponds for at least 60 seconds. Broom over all puddles thoroughly until complete penetration is achieved
6. System Thickness:	Follow CSM's recommendations.
7. Color Selection:	Clear.

3.06 COATING SYSTEMS SCHEDULE (FINISH SCHEDULE)

A. General:

1. Specific coating systems, colors, and finishes for rooms, galleries, piping, equipment, and other items that are coated or have other architectural finishes are specified in the following coating system schedule. Unless otherwise specified in the coating system schedule, the word "interior" shall mean the inside of a building or structure, and the word "exterior" shall mean outside exposure to weather elements.

Coating Systems Schedule (Finish Schedule)

Location/Surface	Coating System Identification	Standard Color
A. General: All Surfaces not Specified by Area or Structure		
1. Structural Steel, Metal Decking, and Galvanized Acoustical Decking	E-2	
2. Equipment and Metal Appurtenances		
a. Equipment, non immersed, unless otherwise specified		
1) Indoors	E-1	See specification 40 05 02
2) Outdoors	EU-1	FS 25051 Blue
b. Equipment, immersed, unless otherwise specified	E-2	Beige
c. High temperature equipment operable at		
1) 200 to 750 degrees F	HH-1	FS 26306 Grey
2) above 750 degrees F to 1200 degrees F	HH-2	Aluminum or Black
d. Existing equipment		
1) Not damaged nor modified by work in this contract	Uncoated	--
2) Damaged, exposed, or modified by work in this contract		
a) Indoors	E-1 (see paragraph 3.02)	Match existing color
b) Outdoors	EU-1 without primer (see paragraph 3.02)	Match existing color
e. Diffusers and grilles on coated surfaces, unless otherwise specified		
1) Indoors	E-1	Match background color
2) Outdoors	EU-1	Match background color
f. Diffusers and grilles on uncoated surfaces, unless otherwise specified		
1) Indoors	E-1	FS 25051 Blue
2) Outdoors	EU-1	FS 20040 Brown
g. Existing diffusers and grilles		
1) Not damaged not modified by work in this contract	Uncoated	--
2) Damaged, exposed, or modified by work in this contract		
a) Indoors	E-1 (see paragraph 3.02 Masonry Surfaces)	Match existing color
b) Outdoors	EU-1 without primer (see paragraph 3.02 Masonry Surfaces)	Match existing color
h. Electrical service entrance equipment, switchboards, power transformers, panelboards and load centers, and relay panels; indoors and outdoors	See paragraph 3.03 Electrical and Instrumentation Equipment and Materials	ANSI 61 Grey (outside) FS 27880 White (inside)
i. Electrical Service Entrance Section	EU-1	As selected by Architect during construction

Coating Systems Schedule (Finish Schedule)

Location/Surface	Coating System Identification	Standard Color
j. Standby Generator	EU-1	As selected by Architect during constructions
k. Instrumentation panels, indicating and transmitting field panels, unless otherwise specified		
1) Indoors	See paragraph 3.03 Electrical and Instrumentation Equipment and Materials	FS 26306 Grey (outside) FS 27880 White (inside)
2) Outdoors	See paragraph 3.03 Electrical and Instrumentation Equipment and Materials	FS 26306 Grey (outside) FS 27880 White (inside)
l. Existing electrical and instrumentation panels		
1) Not damaged by work in this contract	Uncoated	--
2) Damaged or exposed to outside surfaces by work in this contract		
a) Indoors	E-1 (see paragraph 3.02 Masonry Surfaces)	FS 26306 Grey
b) Outdoors	EU-1 without primer (see paragraph 3.02 Masonry Surfaces)	FS 26306 Grey
3. Conduit, Piping and Ductwork		
a. Ferrous, non-ferrous and galvanized piping, and appurtenant hangers and supports, non-immersed, unless otherwise specified.		
1) Indoors – noncorrosive	E-1	See Section 40 05 02
2) Outdoors – noncorrosive	EU-1	
3) Indoors – in corrosive environment	EA-1	
4) Buried piping	M-1 or M-2	
b. Ferrous piping, appurtenant and supports, immersed	E-2	
c. Conduit, outlet and junction boxes, lighting transformers, lighting, communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps, and supports on coated surfaces, unless otherwise specified.		
1) Indoors	E-1	Match background color
2) Outdoors	EU-1	Match background color
d. Conduit, outlets and junction boxes, lighting, control stations, piping, lagged ductwork, appurtenant hangers, clamps and supports on uncoated surfaces, unless otherwise specified		
1) Indoors	E-1	As selcected by Architect during construction

Coating Systems Schedule (Finish Schedule)

Location/Surface	Coating System Identification	Standard Color
2) Outdoors	EU-1	As selected by Architect during construction
e. Existing conduit, outlet and junction boxes, lighting transformers, lighting communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps, and supports		
1) Not damaged nor modified by work in this contract	Uncoated	--
2) Damaged, exposed, or modified by work in this contract		
a) Indoors	E-1 (see paragraph 3.02 Masonry Surfaces)	Match existing color
b) Outdoors	EU-1 without primer (see paragraph 3.02 Masonry Surfaces)	Match existing color
f. Racked conduits and cable trays	Uncoated	--
g. Insulated pipe jacketing	Uncoated	--
h. Plastic, fiberglass and flexible conduit and piping		
1) Unless otherwise specified	Uncoated	--
2) PVC and CPVC Piping	L-2	FS 25051 Blue
a) Exposed to direct sunlight	L-2	FS 25051 Blue
b) Not exposed to direct sunlight	E-7	FS 25051 Blue
i. High temperature piping operable at		
1) 200 to 750 degrees F	HH-1	FS 26306 Grey
2) Above 750 degrees F to 1,200 degrees F	HH-2	Aluminum or Black
j. Exposed ductwork, unless otherwise specified	Uncoated	--
4. Concrete, Grout, Masonry and Plaster		
a. Immersed tank and channel walls and bottoms unless otherwise specified	Uncoated	--
b. Outside concrete walls below grade common with dry area or room	In accordance with Section 07 10 00	--
c. Walls and ceilings		
1) Precast concrete or colored masonry	Uncoated	--
2) Outdoors, unless otherwise specified	Uncoated	--
3) Indoors, unless otherwise specified	E-4	FS 23617 Beige
d. Concrete equipment bases unless otherwise specified	E-4	Match equipment color
e. Floors unless otherwise specified	S-2	
f. Existing coated surfaces.	L-1	Match existing color
5. Door and Door Frames		
a. Doors unless otherwise specified		
1) Ferrous metal		
a) Indoors	E-1	FS 20040 Brown
b) Outdoors	EU-1	FS 25051 Blue
2) Aluminum	Uncoated	--

Coating Systems Schedule (Finish Schedule)

Location/Surface	Coating System Identification	Standard Color
3) Other	Plastic laminate	Formica 947 Brown
4) Existing		
a) Not damaged by work in this contract	Uncoated	--
b) Damaged, exposed, or modified by work in this contract		
(1) Indoors	E-1 (see paragraph 3.02 Masonry Surfaces)	Match existing color
(2) Outdoors	EU-1 (see paragraph 3.02 Masonry Surfaces)	Match existing color
b. Door frames unless otherwise specified		
1) Adjacent wall coated		
a) Indoors	E-1	Match wall color
b) Outdoors	EU-1	Match wall color
2) Adjacent wall uncoated		
a) Indoors	E-1	FS 20040 Brown
b) Outdoors	EU-1	FS 25051 Blue
3) Aluminum	Uncoated	--
4) Existing		
a) Not damaged by work in this contract	Uncoated	--
b) Damaged, exposed, or modified by work in this contract		
(1) Indoors	E-1 (see paragraph 3.02 Masonry Surfaces)	Match existing color
(2) Outdoors	EU-1 without primer (see paragraph 3.02 Masonry Surfaces)	Match existing color
6. Handrails, Gratings, Floor Plates, Manhole Covers, and Hatches		
a. Unless otherwise specified	Uncoated	
b. Existing		
1) Not damaged by work in this contract	Uncoated	--
2) Damaged, exposed, or modified by work in this contract		
a) Indoors	E-1 (see paragraph 3.02 Masonry Surfaces)	Match existing color
b) Outdoors	EU-1 without primer (see paragraph 3.02 Masonry Surfaces)	Match existing color
7. Metal Stairs, Ladders, Platforms, and Supports Except Tread and Grating		
a. Indoors	E-1	FS 25051 Blue
b. Outdoors	EU-1	FS 20040 Brown
c. Existing		
1) Not damaged nor modified by work in this contract	Uncoated	--

Coating Systems Schedule (Finish Schedule)

Location/Surface	Coating System Identification	Standard Color
2) Damaged, exposed, or modified by work in this contract		
a) Indoors	E-1 (see paragraph 3.02 Masonry Surfaces)	Match existing color
b) Outdoors	EU-1 without primer (see paragraph 3.02 Masonry Surfaces)	Match existing color
8. Aluminum Flashing, Light Standards, Supports, and Louvers		
a. Indoors and outdoors, unless otherwise specified	Uncoated	--
9. Precast Concrete Metalwork		
a. Fasteners, anchors, supports, etc.	EU-1	Match wall
10. Other		
a. Fire hydrants	EU-1	FS 21302 Red
b. Flap gates	EA-1	Beige
c. Aluminum slide gates	Uncoated	--
d. Sluice gates		
1) Gate	--	--
2) Stem, except potable	G	--
3) Operator		
a) Indoors	E-2	FS 25051 Blue
b) Outdoors	EU-1	FS 20040 Brown
e. Tanks		
1) Steel tanks unless otherwise specified		
a) Inside of wash water or similar tanks	E-2	--
b) Inside of sludge (open top) tanks	E-9	--
c) Outside of tank		
(1) Indoors	E-1	FS 25051 Blue
(2) Outdoors	EU-1	FS 25051 Blue
2) Potable steel water storage tanks		
a) Inside of tank	E-5	See Note 1
b) Outside of tank	EU-1	FS 25051 Blue
3) Fiberglass tank	Uncoated	--
f. Pipe, ductwork, equipment and appurtenances made from fiberglass, plastic, rubber, including flexible hose, conduit, and plastic coated tubing, in areas not exposed to view (indoors) (metal hangers and supports are coated with E-1)	Uncoated	--
g. Buried, sleeve-type and flanged pipe, couplings, valves, mechanical and electrical penetrations	M-1 or M-2	Manufacturer's color

Note: Owner will select color from coating manufacturer's list of EPA approved colors for potable water.

3.07 INSPECTION AND TESTING BY OWNER

A. General:
   1. Inspection by the Owner or others does not limit the Contractor's or CSA's responsibilities for quality workmanship or quality control as specified or as required by the CSM's instructions. Inspection by the Owner is in addition to any inspection required to be performed by the Contractor.
   2. The Owner may perform, or contract with an inspection agency to perform, quality control inspection and testing of the coating work covered by this Section 09 90 00. These inspections may include the following:
      a. Inspect materials upon receipt to ensure that are supplied by the CSM.
      b. Inspect to verify that specified storage conditions for the coating system materials, solvents and abrasives are provided.
      c. Inspect and record findings for the degree of cleanliness of substrates.
      d. Inspect and record the pH of concrete and metal substrates.
      e. Inspect and record substrate profile (anchor pattern)
      f. Measure and record ambient air and substrate temperature.
      g. Measure and record relative humidity.
      h. Check for the presence of substrate moisture in the concrete.
      i. Inspect to verify that correct mixing of coating system materials is performed in accordance with CSM's instructions.
      j. Inspect, confirm, and record that the "pot life" of coating system materials is not exceeded during installation. Inspect to verify that recoat limitations for coating materials are not exceeded.
      k. Perform adhesion testing.
      l. Measure and record the thickness of the coating system.
      m. Inspect to verify proper curing of the coating system in accordance with the CSM's instructions.
      n. Perform holiday or continuity testing for coatings that will be immersed or coatings that will be exposed to aggressively corrosive conditions.

3.08 FINAL INSPECTION

A. General
   1. Contractor shall conduct a final inspection to determine whether coating system work meets the requirements of the specifications.
   2. The Construction Manager will subsequently conduct a final inspection with the Contractor to determine the work is in conformance with requirements of the contract documents.
   3. Any rework required shall be marked. Such areas shall be recleaned and repaired as specified at no additional cost to the Owner.

END OF SECTION

SECTION 09 97 13.33

COATING FOR STEEL WATER STORAGE RESERVOIR

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies coating systems, surface preparations, and application requirements for coating of a steel water reservoir.

B. Definitions:
   1. Specific coating terminology used in this section is in accordance with definitions contained in ASTM D16, ASTM D3960, and the following definitions:
      a. Dry Film Thickness (DFT):
         1) The thickness of one fully cured continuous application of coating.
      b. Field Coat:
         1) The application or the completion of application of the coating system after installation of the surface at the site of the work.
      c. Shop Coat:
         1) One or more coats applied in a shop or plant prior to shipment to the site of erection or fabrication, where the field or finishing coat is applied.
      d. Volatile Organic Content:
         1) The portion of the coating that is a compound of carbon, is photochemically reactive, and evaporates during drying or curing, expressed in grams per liter or pounds per gallon.
      e. Touch-Up Painting:
         1) The application of a paint on areas of painted surfaces to repair marks, scratches, and areas where the coating has deteriorated to restore the coating film to an unbroken condition.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM D16	Standard Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products
ASTM D2200 (SSPC-Visl-67T)	Pictorial Surface Preparation Standards for Painting Steel Surfaces
ASTM D3359	Methods for Measuring Adhesion by Tape Test--Method A
ASTM D3960	Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM D4417	Field Measurement of Surface Profile of Blast Cleaned Steel
AWWA D102	Painting Steel Water-Storage Tanks
NSF 61	Drinking Water System Components Health Effects
SSPC	Steel Structures Painting Council Specifications, Vol. 2

B. Standardization:
   1. Materials and supplies provided shall be the standard products of manufacturers. Materials in each coating system shall be the products of a single manufacturer.
   2. The standard products of manufacturers other than those specified will be accepted when it is demonstrated to the Construction Manager that they are equal in composition, durability, usefulness, and convenience for the purpose intended. Requests for substitutions will be considered, provided the following minimum conditions are met:
      a. The proposed coating system shall use an equal or greater number of separate coats to achieve the required dry film thickness.
      b. The proposed coating system shall use coatings of the same generic type as that specified.
      c. Requests for substitution shall have directions for application and descriptive literature which includes generic type, percent solids by volume, volatile organic content (grams per liter), and information confirming that the substitution is equal to the specified coating system.
      d. The Contractor shall provide a list of references where paint of the same generic type has been applied. The reference list shall give the project name, city, state, owner, phone number of owner, coating system reference and number, and year paint was applied.

C. Inspection:
   1. The Construction Manager will provide, or arrange to have provided, all coating inspections. Test equipment provided by the Contractor as specified in paragraph 3.04 Inspection and Checking will be operated by the Construction Manager.

2. The Construction Manager will perform inspection on all on-site and off-site phases of the surface preparation, abrasive blast cleaning, and application of the coating systems. Specified and optional tank surfaces to have shop-applied primer will be monitored by off-site inspection. The Contractor shall notify the Construction Manager in sufficient time to schedule inspection during shop priming and shall make the shop priming premises open and available to the Construction Manager for inspection. The Contractor shall pay all costs incurred for off-site inspection.
3. If shop work is not scheduled on a continuous basis to facilitate scheduling by the Construction Manager, all costs incurred for multiple trips to the shop shall be borne by the Contractor. Actual costs incurred for off-site inspection will be incorporated into a change order and deducted from progress payments due the Contractor.

1.03 DELIVERY AND STORAGE

A. Materials shall be delivered to the job site in their original, unopened containers. Each container shall bear the manufacturer's name, coating type, batch number, date of manufacture, storage life, and special directions.

B. Materials shall be stored in enclosed structures and shall be protected from weather and excessive heat or cold. Flammable materials shall be stored in accordance with state and local codes. Materials exceeding storage life recommended by the manufacturer shall be removed from the site.

1.04 SPARE SUPPLIES

A. The Contractor shall provide one unbroken gallon container of each color and type of paint and each type of solvent and thinner required by the specification. These spare paint supplies shall be stored as required in paragraph 1.03 until delivery is requested by the Construction Manager.

PART 2 PRODUCTS

2.01 COATING SYSTEMS

A. General:
   1. All materials of a specified coating system, including primer, intermediate, and finish coats, shall be produced by the same manufacturer. Thinners, cleaners, driers, and other additives shall be as recommended by the coating manufacturer for the particular coating system.

B. Outside Coating:
   1. Primer:
      a. Exterior primer shall be an epoxy compatible for use with urethane, Coating System EU-1, or equal.
   2. Finish Coating:
      a. Exterior finish coating shall be a urethane, Coating System EU-1 or equal. The color of the finish coat shall be Tan.

C. Inside Coating:
   1. Certification:
      a. All inside coatings shall be certified in accordance with NSF 61.
   2. Primer:
      a. Inside primer shall be an epoxy compatible for use with the finish coats, Coating System E-5, or equal.
   3. Finish Coating:
      a. Inside finish coat shall be an epoxy white in color, Coating System E-5 or equal.

2.02 PRODUCT DATA

A. Before materials are delivered to the job site, the Contractor shall provide the following information in accordance with Section 01 33 00:
   1. Manufacturer's standard product data and material safety data sheet for each primer and finish coating.
   2. List of materials proposed to be used under this section.
   3. Manufacturer's literature and written instructions for surface preparation, mixing, and application of each primer and finish coating.

PART 3 EXECUTION

3.01 COATINGS

A. General:
   1. Coating products shall not be used until the Construction Manager has inspected the materials and the coating manufacturer's technical representative has instructed the Contractor and Construction Manager in the surface preparation, mixing and application of each coating.
   2. At least 14 days prior to the shop or field application of the coating systems on the steel tank, the Contractor shall schedule and arrange a conference with the coating applicator, Construction Manager, tank manufacturer, and the coating manufacturer to coordinate the following:
      a. Tank manufacturer's work schedule for inspection coordination.
      b. Surface preparation prior to abrasive blast cleaning.
      c. Specification compliance of blast abrasives and surface profile.
      d. Schedule of blast cleaning and coating application.
      e. List of equipment for cleaning and coating applications.
      f. Weather limitations for acceptable work.
      g. Inspection facilities and test equipment.

B. Coating Systems:
   1. Shop Applied Prime Coat:

2. Except as otherwise specified, prime coats may be shop- or field-applied. Shop-applied primer shall be compatible with the specified coating system and shall be applied at the minimum dry film thickness recommended by the manufacturer. Product data sheets identifying the shop primer used shall be provided to the on-site finish coat applicator. Adhesion tests shall be performed on the shop primer as specified in paragraph 3.02 General. Damaged, deteriorated and poorly applied shop coatings that do not meet the requirements of this section shall be removed and the surfaces recoated. If the shop primer coat meets the requirements of this section, the field coating may consist of touching up the shop prime coat and then applying the finish coats to achieve the specified film thickness and continuity.
3. Field Coats:
    a. Field coats shall consist of one or more prime coats and one or more finish coats to build up the coating to the specified dry film thickness. Unless otherwise specified, finish coats shall not be applied until other work in the area is complete and until all previous coats have been inspected.

3.02 PREPARATION

A. General:
1. Surfaces to be coated shall be clean and dry. Before applying coating or surface treatments, oil, grease, dirt, rust, loose mill scale, old weathered coatings, and other foreign substances shall be removed except as specified. Oil and grease shall be removed before mechanical cleaning is started. Where mechanical cleaning is accomplished by blast cleaning, the abrasive used shall be washed, graded and free of contaminants which might interfere with the adhesion of the coatings. The Contractor shall examine all surfaces to be coated and shall correct all surface defects before application of any coating.
2. Clean cloths and clean fluids shall be used in solvent cleaning. Cleaning and painting shall be scheduled so that dust and spray from the cleaning process shall not come in contact with wet, newly painted surfaces.
3. The Contractor shall perform an adhesion test in accordance with ASTM D3359 to demonstrate that (1) the shop primer adheres to the substrate, and (2) the specified field coatings adhere to the shop primer. Test results showing an adhesion rating of 5A on immersed surfaces and 4A or better on all other surfaces shall be considered acceptable. Where unacceptable test results are obtained, the Contractor shall be responsible for removing and reapplying the specified coatings at no expense to the Owner.

B. Metallic Surfaces:
1. Metallic surfaces shall be prepared in accordance with applicable portions of surface preparation specifications of the Steel Structures Painting Council (SSPC). Unless otherwise specified, interior ferrous metal surfaces shall be prepared in accordance with SSPC SP 5 (White Metal Blast Cleaning) and exterior ferrous metal surfaces prepared in accordance with SSPC SP 6 (Commercial Blast Cleaning). The profile depth of the surface to be coated shall be 20 to 25 percent of the coating dry film thickness as measured by Method C of ASTM D4417. Blast particle size shall be selected by the contractor to produce the specified surface profile. The solvent in solvent cleaning operations shall be as recommended by the manufacturer.

2. Preparation of metallic surfaces shall be based upon comparison with SSPC-Visl-67T (ASTM D2200), and as described herein. To facilitate inspection, the Contractor shall, on the first day of sandblasting operations, sandblast metal panels to the standards specified. Plates shall measure a minimum of 8-1/2 inches by 11 inches. Panels meeting the requirements of the specifications shall be initialed by the Contractor and the Construction Manager and coated with a clear nonyellowing finish. One of these panels shall be prepared for each type of sandblasting and shall be used as the comparison standard throughout the project.

C. Abrasive Blast Cleaning:
   1. The specified limitations on the application of coatings also applies to blast cleaning. Blast cleaning shall only be done when conditions permit the immediate subsequent application of coating, and only for the area that can be coated with primer or touch-up coating during the same day. Changed humidity or a delay, such as equipment failure, may cause a cleaned surface to color or slightly oxidize from condensation before the coating can be applied. In the event that a surface colors or becomes moist, it shall be blast cleaned again before applying the coating.
   2. Abrasive blast cleaning shall comply with the following:
      a. Dry abrasive blast shall be used for cleaning metal surfaces. Sand used for cleaning shall be washed, uniformly graded, dry, and free of contaminants. Sand containing salt or unwashed beach sand shall not be used. When shop blast cleaning with stationary automatic equipment that recycles the blast particles, new abrasives shall be used in the equipment at the beginning of the blast cleaning operations. Use of abrasives that have become contaminated in automatic equipment is prohibited. When shop or field blast cleaning with hand-held nozzles, blast particles shall not be recycled or reused.
      b. After blast cleaning and prior to application of coating, surfaces to be coated shall be dry cleaned by dusting, sweeping, and vacuuming to remove residue from blasting. The blasting and the specified primer or touch-up coating shall be applied within the period of an 8-hour working day. Coating shall not be applied over damp or moist surfaces. Prior to application of primer or touch-up coating, any blast cleaned surface not coated within the 8-hour period shall be recleaned.
      c. The area of the work shall be kept in a clean condition and blasting particles shall not be permitted to accumulate and constitute a nuisance or hazard. The reservoir inlet, outlet, drain, and overflow piping shall be covered, and blasting particles prevented from being blown into the piping.
      d. During blast cleaning, caution shall be exercised to prevent damage to adjacent preapplied coatings. Blast cleaning and coating shall be scheduled such that dust, dirt, blast particles, old coatings, rust, mill scale, etc., shall not damage or come in contact with wet or newly coated surfaces. Damaged coatings shall be restored to their specified condition.

3.03 APPLICATION

A. Workmanship:
   1. Coated surfaces shall be free from runs, drops, ridges, waves, laps, and brush marks. Coats shall be applied so as to produce an even film of uniform thickness completely coating corners and crevices. Painting shall be done in accordance with the requirements of SSPC Paint Application Specification No. 1.

2. The Contractor's equipment shall be designed for application of the materials specified. Compressors shall have suitable traps and filters to remove water and oils from the air. Spray equipment shall be equipped with mechanical agitators, pressure gages, and pressure regulators, and spray nozzles of the proper sizes.
3. Each coat of paint shall be applied evenly and sharply cut to line. Care shall be exercised to avoid overspraying or spattering paint on surfaces not to be coated. Glass, hardware, floors, roofs, and other adjacent areas and installations shall be protected by taping, drop cloths, or other suitable measures.

B. Paint Properties, Mixing and Thinning:
1. Paint, when applied, shall provide a satisfactory film and smooth even surface, and glossy undercoats shall be lightly sanded to provide a surface suitable for the proper application and adhesion of subsequent coats. Paints shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings consisting of two or more components shall be mixed in accordance with the manufacturer's instructions. Where necessary to suit the conditions of the surface, temperature, weather and method of application, the paint may be thinned immediately prior to use. The volatile organic content (VOC) of the coating as applied shall comply with prevailing air pollution control regulations. Unless otherwise specified, paint shall not be thinned more than necessary to obtain the proper application characteristics. Thinner shall be as recommended by the coating manufacturer.

C. Atmospheric Conditions:
1. Paints shall be applied only to surfaces that are dry, and only under conditions of evaporation rather than condensation. Paint shall not be applied during rainy, misty weather, or to surfaces upon which there is frost or moisture condensation. Coatings shall not be applied when the temperature of the surface to be coated is more than 5 degrees F below the air temperature, or when the surface temperature is over 120 degrees F. During painting, and for a period of at least 8 hours after the paint has been applied, the temperature of the surfaces to be painted, the painted surfaces, and the atmosphere in contact shall be maintained at or above 50 degrees F and at least 10 degrees F above the dew point. Paint, when applied, shall be approximately the same temperature as that of the surface on which it is applied. Fans or heaters shall be used inside enclosed areas where conditions causing condensation exist.
2. If conditions are adverse as noted above, the application of coating shall be delayed or postponed until conditions are favorable. Dew or moisture condensation should be anticipated and if such conditions are prevalent, coating work shall be delayed until midmorning to be certain that the surfaces are dry. The day's coating shall be completed in time to permit the film sufficient drying time prior to damage by climatic conditions. Climatic conditions will be monitored by the Construction Manager to aid in inspection. If a change in climatic conditions damages a coating application, repair of the damaged coatings to their specified condition shall be made at no additional cost to the Owner.

D. Protection of Coated Surfaces:
1. Items which have been coated shall not be handled, worked on, or otherwise disturbed, until the paint is completely dry and hard. After delivery to the site and permanent erection or installation, shop-coated metalwork shall be repainted or retouched with specified paint when it is necessary to maintain the integrity of the film.

E. Procedures:
   1. General:
      a. Procedures for application of coatings shall comply with the following:
         1) Coating applicator shall conform to the requirements of SSPC PA-1 and follow the recommendations of the coating manufacturer including the selection of spray equipment, brushes, rollers, cleaners, thinners, mixing, drying time, temperature and humidity of application, and safety precautions.
         2) Coating applicator shall stir, strain, and keep coating materials at a uniform consistency during application. A different shade or tint shall be used on succeeding coating applications to indicate coverage. Finished surfaces shall be free from defects or blemishes.
         3) If allowed, thinning shall not exceed the maximum allowable amount of thinner per gallon of coating material. Coating materials shall be stirred at all times when adding thinner; flooding the coating material surface with thinner prior to mixing is prohibited. Coating materials shall not be thinned more than is absolutely necessary to obtain the proper application characteristics and to obtain the specified dry-film thicknesses.
      b. Blast cleaned surfaces shall be cleaned as specified in paragraph 3.02 Abrasive Blast Cleaning. Ventilator fans shall be used to clean airborne dust to provide good visibility of working area prior to coating applications. Dust shall be removed from coated surfaces by dusting, sweeping, and vacuuming prior to applying succeeding coats.
         1) Coating applicator shall observe minimum and maximum recoat times between primer and succeeding coating applications to achieve maximum crosslinking of coatings. If the recommended minimum or maximum recoat time is violated, the surface shall be prepared as directed by the coating manufacturer. A second application of the primer or coating shall be applied if the maximum recoat time has been exceeded.
         2) Coating systems shall be applied to the specified minimum dry-film thicknesses as measured from above the peaks of the surface profile. Measurement will be in accordance with SSPC PA-2 and will be corrected for the magnetic effect of the surface profile.
         3) Primer or touch-up coating shall be applied immediately after blast cleaning and before any surface rusting occurs, or any dust, dirt, or any foreign matter has accumulated. Steel surfaces that have surface colored or become moist prior to coating application shall be recleaned by blast cleaning.
   2. Shop-Applied Primers:
      a. Procedures for application of shop-applied primers shall comply with the following:
         1) Blast-cleaned steel surfaces will be tested by the Construction Manager utilizing chemical and/or ultraviolet (black light) tests to detect oil and other contaminants deposited on the surface from abrasive recycling. Tests will be conducted prior to the application of primers. Contaminated surfaces shall be recleaned using new abrasives in the equipment and the surfaces prepared as specified.
         2) After application of primer to steel surfaces, coating shall be allowed to cure for a minimum of 2 hours before handling, to minimize damage.

3) When loading for shipment to the project site, spacers and other protective devices shall be used to separate the plates and steel members to prevent damaging the shop-primed surfaces during transit and unloading. If wood spacers are used, wood splinters and particles shall be removed from the shop-primed surfaces after separation. Padded chains or ribbon binders shall be used to secure the loaded steel and minimize damage to the shop-primed surfaces.

4) Shop-primed steel surfaces shall be completely covered with protective coverings or tarpaulins to prevent deposition of road salts, fuel residue, and other contaminants in transit.

5) Shop-primed steel plates and members shall be handled with care during unloading and erection operations to minimize damage. Sliding steel across another plate or member, except for fitting plates into final position during roof construction is prohibited. Shop-primed steel shall not be placed or stored on the ground or on top of other steelwork unless ground or steelwork is covered with a protective covering or tarpaulin. Steel above the ground shall be placed upon platforms, skids, or other supports.

3. Touch-Up of Shop-Applied Primers:

a. Touch-up of shop-applied primers after erection shall comply with the following:

1) After erection, the Construction Manager will inspect all surfaces of the tank to determine surface deficiencies in the shop-applied primers. Contaminants that have accumulated on the surfaces of the shop-applied primers during shipment, storage, and erection shall be removed and corrective action performed as noted.

2) Coating applicator shall remove oil and grease surface contaminants in accordance with SSPC SP-1. The coating applicator shall use clean rags wetted with a degreasing solution, rinse with clean water, and wipe dry.

3) Coating applicator shall remove dust, dirt, salts, moisture, chalking primers, or other surface contaminants that will affect the adhesion or durability of the coating system by using a high-pressure water blaster or scrubbing all surfaces with a broom or brush wetted with a solution of trisodium phosphate, detergent, and water. Scrubbed surfaces shall be rinsed with clean water.

4) Loose or peeling primer and other surface contaminants not easily removed by the previous cleaning methods shall be removed in accordance with SSPC SP-7. Care shall be taken that remaining primers are not damaged by the blast-cleaning operation. Remaining primers shall be firmly bonded to the steel surfaces with blast-cleaned edges feathered.

5) Coating applicator shall remove rust, scaling, or primer damaged by welding or during shipment, storage, and erection in accordance with SSPC SP-10. Care shall be taken that remaining primers are not damaged by the blast cleaning operation. Remaining primers shall be firmly bonded to the steel surfaces with blast-cleaned edges feathered.

6) Repair procedures used on damaged primer shall protect adjacent primer. Blast cleaning may require the use of lower air pressure, smaller nozzles and abrasive particle sizes, short blast nozzle distance from surface, shielding, and/or masking.

7) If damage to primer in a specific area exceeds 50 percent of the total surface of that specific area, area shall be cleaned by blasting in accordance with SSPC SP-10 and a second application of the specified primer applied to the total surface of the specific area. Specific areas are defined as follows: underside of roof and support structure, shell interior, roof exterior, and shell exterior.

8) When primed surfaces have exceeded the manufacturer's recommended recoat time or recoat time when exposed to sunlight, surface shall be blast cleaned in accordance with SSPC SP-10 and a second coat of the specified primer applied.

4. Field-Applied Interior Primer and Coating:
   a. Procedures for application of field-applied interior primer and coating shall comply with the following:
      1) Coating applicator shall remove dust from the sandblasted surface and allow ventilator fans to clear airborne dust to provide good visibility of working area. Adequate lights shall be provided.
      2) Dust shall be removed from primer before applying second coat. Total mil thickness shall be verified. Floor shall be coated last.
      3) The coating will be checked with a holiday detector as the work progresses. A final check of the entire coating will be performed when it is complete.
5. Exterior Coating:
   a. Procedures for application of exterior coatings shall comply with the following:
      1) Coating applicator shall remove sandblasted dust. Primer shall be applied with rollers that leave a smooth surface or by spraying. Rollers shall be used when wind causes unacceptable drift. The finish coats shall be sprayed except spraying is not allowed when wind or other weather conditions are unfavorable.
      2) The mil thickness and the dryness of each coat shall be verified before overcoating.
6. Limitations on Coating Applications:
   a. Coatings shall not be applied under the following conditions:
      1) When the air and surface temperature are outside the range recommended by the coating manufacturer.
      2) When the ambient temperature is less than 5 degrees F above the dew point.
      3) When the surfaces are wet or moist.
      4) During rain, snow, fog, or mist.
      5) When it is expected that the air temperature will drop below that recommended by the paint manufacturer or will drop to less than 5 degrees F above the dew point within 8 hours after applying the coating.
      6) Coating applicator shall maintain a thermometer in the shade on the project site and keep informed of the dew point and the humidity from the weather bureau.

F. Cleaning and Coating of Roof Plates and Framing:
   1. Before erection of the roof framing, all sides of the roof framing members and the roof plates that will be in contact with them shall be cleaned and painted with the specified prime coat. After erection, visible scratches and other damaged painted surfaces shall be sandblasted, primer applied to the recleaned areas, then finish coat applied along with other interior surfaces.

G. Underside of Flat Bottom Tanks:
   1. The underside of flat bottom tanks shall not be coated.

H. Cleaning and Coating of Overflow Piping Within Tank:
   1. The interior and exterior of overflow piping within the tank shall be cleaned and coated as specified for the tank interior.

I. Paint Thickness and Minimum Number of Coats:
   1. General:
      a. The number of coats specified shall be applied unless the measured dry-film thickness is less than specified, in which case additional coats shall be applied.
   2. Interior:
      a. Epoxy system
         Primer 5 mils
         Finish 5 mils
         10 mils minimum
   3. Exterior:
      a. Urethane system
         Primer 5 mils
         Finish 2 mils
         7 mils minimum

3.04 INSPECTION

A. Inspection Facilities:
   1. Contractor shall provide the Construction Manager with facilities for inspection consisting of the following:
      a. Safety equipment and devices required during abrasive blast cleaning and coating operations. Helmet with continuous fresh air supply shall be provided for observation during cleaning operations.
      b. Illumination and the manpower to move the lights, whenever required by the Construction Manager. Additional lights and supports shall be sufficient to illuminate all areas to be inspected. The Construction Manager will determine the level of illumination required for inspection purposes.
      c. Temporary ladders and scaffolding as required to provide access to the locations requested by the Construction Manager.

B. Inspection and Checking:

1. The Construction Manager will perform such tests as are required to demonstrate substantial compliance with all phases of the surface preparation, abrasive blast cleaning, and application of the coating systems. Test equipment shall include the following: SSPC surface preparation standards, surface profile comparator, test tape, micrometer, abrasive sieve test, ultraviolet lamp, mirror, certified thickness calibration plates, magnetic-type dry-film thickness gage, nondestructive holiday detector, and nonsudsing-type wetting agent. Equipment will be calibrated by the Construction Manager in the presence of the Contractor to verify its accuracy prior to use. The Contractor shall provide the test equipment.
2. The Construction Manager shall be notified 5 working days in advance of shop and field operations involving abrasive blast cleaning and coating applications. The Construction Manager will determine the degree and surface profile of the shop and field blast cleaned surface. Additional blast cleaning shall be performed over areas not conforming to the specified surface preparation.
3. The Construction Manager will inspect each coat of primer, touch-up, intermediate, and finish coating to determine thickness and integrity. Each coating application will be checked and deficiencies marked. After observing specified recoat time, additional coating materials shall be applied over area not having the specified minimum dry-film thickness and areas having any holidays or pinholes. After correction of deficiencies, the Construction Manager will reinspect those areas to determine the acceptability of additional coating. Each coating application shall be 100 percent to the satisfaction of the Construction Manager prior to succeeding coating applications.

3.05 WARRANTY

A. A first-anniversary warranty inspection of the interior and exterior surfaces of the tank will be conducted during the eleventh month following final acceptance of the work by the Owner to determine whether any repair work is necessary. Inspection shall comply with Section 9 of AWWA-D 102 except as specified. The Owner will establish the inspection date and notify the Contractor. The Owner will drain and wash down the tank. The Contractor shall provide lighting and scaffolding for the tank inspection. Where coatings have peeled off, bubbled, or cracked, and any location where rusting is evident shall be considered to be a failure of the coating system. Repairs at failures shall be performed by removing the deteriorated coating; preparing the surface by abrasive blast cleaning and applying the same coating systems as specified in this section. Inspection and repairs shall be performed at no cost to the Owner.

END OF SECTION

SECTION 10 14 00

SIGNAGE

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies informational and accident prevention signs.

1.02 OPERATING AND DESIGN REQUIREMENTS

A. General:
   1. Accident prevention signs shall conform as to design with OSHA Section 1910.145 of Subpart J, Part 1910, Chapter XVII, Title 29 of the Code of Federal Regulations. Exit signs shall conform with Section 1910.37(g) of the OSHA Safety and Health Standard for General Industry, Article 10, Section 10.113 of the Uniform Fire Code, and where applicable with local fire regulations.
   2. In addition to the signs identified on the schedule in Part 3 of this section, the following shall be provided:
      a. Exit signs shall be provided in accordance with Section 26 51 19.
      b. "Caution Automatic Equipment May Start at Any Time" signs shall be provided in accordance with paragraph 43 05 11-2.07.

B. Design Requirements:
   1. Size:
      a. Sign size shall be as follows:
         1) 14 inch x 20 inch
         2) 10 inch x 14 inch
         3) 7 inch x 10 inch
   2. Type:
      a. The sign type shall be as follows:

Type	Message
I	RESTRICTED AREA – AUTHORIZED PERSONNEL ONLY
III	CAUTION – AUTOMATIC EQUIPMENT MAY START AT ANY TIME
IV	ELECTRICAL ROOM
V	DANGER – 480 VOLTS
VI	STANDBY GENERATOR LOCATED (CARDINAL DIRECTION) OF SES
VII	CAUTION – COMPRESSED AIR HAZARD REFER TO STANDARD OPERATING PROCEDURES
VIII	CONFINED SPACE. PERMIT REQUIRED FOR ENTRY
IX	NFPA DIAMOND FOR CHLORINE
X	DANGER--CHLORINE
XI	CAUTION—WAIT 5 MINUTES AFTER FAN HAS BEEN SWITCHED ON BEFORE ENTERING BUILDING
XII	DANGER—HIGH VOLTAGE
XIV	LOCK OUT SWITCH BEFORE WORKING ON EQUIPMENT

PART 2 PRODUCTS

2.01 GENERAL

A. Sign lettering shall be single stroke and shall contrast in color with the background. For those messages for which there are international symbols, the international symbols shall be used. Chain mounted signs shall have lettering on both sides.

2.02 MATERIALS

A. Signs shall be 0.100-inch thick fiberglass with embedded fadeproof legends.

PART 3 EXECUTION

3.01 GENERAL

A. Signs shall be distributed as follows:

Location	Number	Size	Message	Mount
Intake Control Building - exterior				
Gate	1	3	I	Fence
Gate	1	3	XII	Fence
Electrical Service Entrance Section	1	3	VI	Door
Control Room	2	3	XII	Door
Control Room	2	2	I	Door
Existing Intake Building - interior				
Pumps	1 each	2	XIV	Post
Pumps	1 each	3	III	Post
Water Treatment Plant - exterior				
Electrical Room	2	2	I	Door
Electrical Room	2	2	IV	Door
Chlorine Room Entrance	2	2	I	Door
Chlorine Building Entrance and Site Gate	2	3	IX	Wall
All 480-Volt Electrical Equipment: SES, Transfer Switch, Standby Generator, VFD, Panelboard, etc.	As needed	3	V	Door
Electrical Service Entrance Section	1	3	VI	Door
Water Treatment Plant - interior				
All Manually-Operated Valves Connected to Suction and Discharge Surge Tanks	As needed	3	VII	Post
Suction and Discharge Surge Tank Manways	NA	2	VIII	Post
Pumps	Doors to Process Area	1	III	Door
Pump Station No. 3 - exterior				
Gate	1	3	I	Fence
Gate	1	3	XII	Fence
Pump Room	2	3	XII	Door
Pump Room	2	2	I	Door
Pump Station No. 3 - interior				
Pump Room	4	3	III	Wall
Pumps	1 each	2	XIV	Wall or Post
Access Hatches and Manhole Entries	1 each	3	VIII	Underside of Hatch or Wall near Ladder

END OF SECTION

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SECTION 10 28 00

TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Public-use washroom accessories.
   2. Public-use shower room accessories.
   3. Underlavatory guards.
   4. Custodial accessories.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each finish specified, full size.
   1. Approved full-size Samples will be returned and may be used in the Work.

C. Delegated Design Submittal: For grab bars.
   1. Include structural design calculations indicating compliance with specified structural-performance requirements.

1.03 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.05 WARRANTY

A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Structural Performance: Design accessories and fasteners to comply with the following requirements:
   1. Grab Bars: Installed units are able to resist 250 lbf concentrated load applied in any direction and at any point.

C. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. ASI-American Specialties, Inc.
   b. Bobrick Washroom Equipment, Inc.
   c. Bradley Corporation.

2.02 PUBLIC-USE WASHROOM ACCESSORIES

A. Toilet Tissue (Roll) Dispenser:
   1. Description: Double-roll dispenser.
   2. Mounting: Surface mounted.
   3. Operation: Noncontrol delivery with standard spindle.
   4. Capacity: Designed for 4-1/2- or 5-inch- diameter tissue rolls.
   5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

B. Combination Towel (Folded) Dispenser/Waste Receptacle:
   1. Description: Combination unit for dispensing C-fold or multifold towels, with removable waste receptacle.
   2. Mounting: Surface mounted.
   3. Minimum Towel-Dispenser Capacity: 600 C-fold or 800 multifold paper towels.
   4. Minimum Waste-Receptacle Capacity: 4 gal..
   5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
   6. Liner: Reusable, vinyl waste-receptacle liner.
   7. Lockset: Tumbler type for towel-dispenser compartment.

C. Soap Dispenser:
   1. Description: Designed for manual operation and dispensing soap in liquid or lotion form.
   2. Mounting: Vertically oriented, surface mounted.
   3. Lockset: Tumbler type.
   4. Refill Indicator: Window type.

D. Grab Bar:
   1. Mounting: Flanges with concealed fasteners.
   2. Material: Stainless steel, 0.05 inch thick.
      a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin).
   3. Outside Diameter: 1-1/2 inches.
   4. Configuration and Length: As indicated on Drawings.

E. Mirror Unit:
   1. Frame: Stainless steel angle, 0.05 inch thick.
      a. Corners: Welded and ground smooth.
   2. Size: As indicated on Drawings.
   3. Shelf:
      a. Type: Integral, welded.
      b. Depth: 5 inches.
   4. Hangers: Manufacturer's standard rigid, tamper and theft resistant.

F. Hook:
   1. Description: Double-prong unit.
   2. Mounting: Exposed.
   3. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

2.03 UNDERLAVATORY GUARDS

A. Underlavatory Guard:
   1. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
   2. Material and Finish: Antimicrobial, molded plastic, white.

2.04 CUSTODIAL ACCESSORIES

A. Custodial Mop and Broom Holder:
   1. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
   2. Length: 36 inches.
   3. Hooks: Four.
   4. Mop/Broom Holders: Three, spring-loaded, rubber hat, cam type.
   5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
      a. Shelf: Not less than nominal 0.05-inch-thick stainless steel.
      b. Rod: Approximately 1/4-inch-diameter stainless steel.

2.05 FABRICATION

A. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install accessories in accordance with manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
   1. Remove temporary labels and protective coatings.

B. Grab Bars: Install to comply with specified structural-performance requirements.

END OF SECTION

SECTION 10 44 16

FIRE EXTINGUISHERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.04 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.05 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Six years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.02 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Amerex Corporation.
      b. Ansul; brand of Johnson Controls International plc, Building Solutions North America.
      c. Babcock-Davis.
      d. Badger Fire Protection; a Carrier company.
      e. Guardian Fire Equipment, Inc.
      f. J. L. Industries, Inc.; Activar Construction Products Group, Inc.
      g. Kidde; Carrier Global Corporation.
      h. Larsen's Manufacturing Company.
      i. Nystrom, Inc.
   2. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

B. Multipurpose Dry-Chemical Type: UL-rated 4-A:80-B:C, 10 lb. nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

2.03 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
   1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
      a. Orientation: Vertical.

PART 3 EXECUTION

3.01 INSTALLATION

A. Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.
   1. Mounting Height: Top of fire extinguisher to be at 42 inches above finished floor.

END OF SECTION

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SECTION 12 34 50

LABORATORY COUNTER TOPS, SINKS AND PEGBOARDS

PART 1 GENERAL

1.01 SUMMARY

A. This specification section covers counter tops specifically manufactured for laboratory use.

B. Section Includes:
   1. Work surfaces
      a. Epoxy resin work surfaces
   2. Accessories
      a. Sinks
      b. Pegboards
      c. Joint adhesive

C. Related Sections;
   1. Division 12 Laboratory Casework

1.02 REFERENCES

A. SEFA 3 – Scientific Equipment and Furniture Association

B. ASTM International

1.03 SUBMITTALS

A. Shop Drawings:
   1. Approval drawings shall be submitted on pages no less than 11” x 17” and 3/8” scale.
   2. Drawings shall include but not be limited to:
      a. overall counter top size
      b. dotted-in base cabinet and knee space locations
      c. sink size and sink cutout locations
      d. fixture drilling size and locations
      e. column cutouts
      f. all counter top cutout and drilling size and locations and seam locations
   3. As most practical, seams shall be located at the intersection of base cabinets.
   4. Seams shall not be placed in knee space areas and as far from sinks as practical.
   5. Counter top sizes shall be of the largest practical size while allowing delivery into the building, floor and room.
   6. Any one particular counter top piece should weigh no more than 350 lbs.

B. Field Dimensions
   1. Dimensions shall be field verified prior to fabrication by qualified factory or dealer representative to ensure proper fit of fabricated and delivered materials.

2. Field dimensions are to be transferred to production and final drawings.

C. Product Data
1. Submit product data that details material origin and design, thickness, durability, performance test results, specification, edge design and color availability.

D. Samples
1. Epoxy samples shall be no less than 1" thick x 4" x 4".
2. Samples shall be clearly marked with manufacturer name and product specifics.

E. Test Reports
1. Submit 3rd party test reports showing evaluations and adherence to SEFA 3 qualifications.

F. Closeout Submittals:
1. Submit owner's manual and recommended maintenance information.

1.04 DELIVERY, STORAGE AND HANDLING

A. Delivery
1. Materials shall only be delivered to a jobsite after internal atmosphere condition has occurred, ceiling grid is installed and drywall has been painted.
2. Storage of epoxy tops in outside conditions is only acceptable when extreme temperatures and weather conditions are not present.
3. Tops must be covered and away from UV exposure.

B. Storage
1. Epoxy tops shall be stored vertically or horizontally as per manufacturers' recommendations.
2. In all cases, tops shall be properly supported to eliminate bending and warping of stored materials.
3. Tops shall be stored on oversized pallets of a size suitable to support the size and weight of all combined materials.
4. Top corners and edges are to be additionally protected using heavy thickness cardboard or plastic material.

C. Handling
1. Epoxy tops are heavy and shall be handled by qualified machinery or personnel to ensure personal, product and peripheral safety.
2. Tops are to be removed from pallets without causing scratches or damage to other tops.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Epoxy counter tops shall be Kemresin as supplied by Kewaunee Scientific located in Statesville, NC. Substitutions may be accepted after following the substitution request as found in Division 1 documentation. In all cases, counter tops shall be manufactured by the same Division 12 casework and Div 11 fume hoods manufacturer.

B. Qualified manufacturers shall have 10+ years of documented and successful installations. Manufacturers shall have United States based modern production facility consisting of loading docks, material handling, raw material formulation, pour, bake, setting, CNC manufacturing and storage capabilities. Qualified manufacturer shall employ the use of a closed mold system.

2.02 MATERIALS

A. Epoxy resin shall be a monolithic poured material consistent throughout material thickness. The finished surface shall have a smooth finish resulting in enhanced stain, scratch and abrasion resistance.

B. Minimum sheen level shall be between 10-70 GU at 60°.

2.03 WORKSURFACES

A. MATERIALS
   1. Epoxy Resin Tops (Kemresin):
      a. Epoxy Resin tops shall consist of modified epoxy resin that has been especially compounded and cured to provide the optimum physical and chemical resistance properties required of a heavy-duty laboratory table top. Tops and curbs shall be a uniform mixture throughout their full thickness, and shall not depend upon a surface coating that is readily removed by chemical and/or physical abuse. Tops shall be 1" thick, exposed edges with a 1/8", 45 degree bevel on top and bottom and drip grooves provided on the underside at all exposed edges. 4" high curbs at the backs and ends of tops shall be 1" thick and bonded to the deck to form a square watertight joint. Sink cutouts shall be smooth and uniform without saw marks with the top edge beveled. The bottom edge of the sink opening shall be finished smooth with the edge broken to prevent sharpness. Corners of sink cutouts shall be radiused not less than 3/4".
      b. Color to be: Black.

2.04 ACCESSORIES

A. Manufacturer to provide a full range of matching epoxy products including but not limited to; sinks and pegboards.

B. Molded Epoxy Resin Sinks (Kemresin)
   1. Sinks shall be molded of modified epoxy resin, carefully compounded with selected materials to provide maximum physical and chemical properties.
   2. Sinks shall possess a high resistance to mechanical and thermal shock.
   3. All inside corners to be coved and the bottom pitched to the drain outlet.
   4. Manufacturer shall supply a full range of epoxy poured, single piece epoxy sinks available in manufacturers' standard colors.
   5. Sinks shall be one piece and be available in under-mount or drop-in configurations.
   6. Sink outlets shall be supplied loose and to be installed by respective trades.
   7. Sink traps to be furnished and installed under Division 23 trade.

C. Pegboards
   1. Manufacturer shall supply epoxy pegboards matching epoxy counter tops.
   2. Pegboards to be 1" thick.

3. Exposed edges with 1/8", 45 degree beveled chamfer and finished.
4. Back of pegboard, when exposed, to be finished.
5. Pegboard to be factory machined to accept polypropylene pegs. Pegs shall be supplied with pegboard.
6. Standard line of products shall include an applied drip trough made of epoxy resin or stainless steel.
7. Drip trough shall include a means to attach a drain tube. Drain tube shall be included when a drip trough is purchased.

D. Field joint epoxy
1. Field joints to be filled using Smooth-On PC3 as manufactured by Smooth-On East Texas, PA www.smooth-on.com.

2.05 PERFORMANCE

A. WORK TOP PERFORMANCE REQUIREMENTS:
1. Molded Epoxy Resin (Kemresin and EarthResin):
a. Physical Properties:

Flexural Strength (A.S.T.M. Method D790-90) =	15,000 PSI
Compressive Strength (A.S.T.M. MethodD695-90) =	30,000 PSI
Hardness, Rockwell E (A.S.T.M. Method D785-89) =	100
Water Absorption (A.S.T.M. Method D570-81)% by weight, 24 Hours =	0.04
% by weight, 7 Days =	0.05
% by weight, 2 Hour Boil =	0.04
Specific Gravity =	1.97
Tensile Strength =	8,500 PSI
Burn Characteristics =	Class 0, A
Thermal Expansion =	34 10-6
Fire Resistance =	Self Extinguishing
Heat Deflection =	Should not be exposed to dry ice or liquid nitorgen

b. Performance Test Results (Heat Resistance):
1) A high form porcelain crucible, size 0, 15 ml capacity, shall be heated over a Bunsen burner until the crucible bottom attains an incipient red heat. Immediately, the hot crucible shall be transferred to the top surface and allowed to cool to room temperature. Upon removal of the cooled crucible, there shall be no blisters, cracks or any breakdown of the top surface whatsoever.

c. Performance Test Results (Chemical Resistance):
1) Tops shall resist chemical attacks from normally used laboratory reagents. Weight change of top samples submerged in the reagents* listed in the next paragraph for a period of seven (7) days shall be less than one-tenth of one percent, except that the weight change for those reagents marked with ** shall be less than one percent. (Tests shall be performed in accordance with A.S.T.M. Method D543-67 at 77o F.).
2) *Where concentrations are indicated, percentages are by weight.

Acetic Acid, Glacial	Iso-Octane
Acetic Acid, 5%	Kerosene
Acetone	Methyl Alcohol
Ammonium Hydroxide, 28%	Mineral Oil
Ammonium Hydroxide, 10%	Methyl Ethyl Ketone
Aniline Oil	Nitric Acid, 70%**
Benzene	Nitric Acid, 40%
Carbon Tetrachloride	Nitric Acid, 10%
Chromic Acid, 40%**	Oleic Acid
Citric Acid, 10%	Olive Oil
Cottonseed Oil	Phenol, 5%
Dichromate Cleaning Solution**	Soap Solution, 1%
Diethyl Ether	Sodium Carbonate, 20%
Dimethyl Formamide	Sodium Carbonate, 2%
Distilled Water	Sodium Chloride, 10%
Detergent Solution, 1/4%	Sodium Hydroxide, 50%
Ethyl Acetate	Sodium Hydroxide, 10%
Ethyl Alcohol, 95%	Sodium Hydroxide, 1%
Ethyl Alcohol, 50%	Sodium Hypochlorite,5%
Ethylene Dichloride	Sulfuric Acid, 85%
Heptane	Sulfuric Acid, 30%
Hydrochloric Acid, 37%	Sulfuric Acid, 3%
Hydrochloric Acid, 10%	Toluene
Hydrogen Peroxide, 28%	Transformer Oil
Hydrogen Peroxide, 3%	Turpentine
NOTE: Dichromate cleaning solution is a formula from Lange's Handbook of Chemistry.	

d. Performance Test Results (Chemical Spot Tests - 24 Hours):

e. Chemical spot tests shall be made by applying 10 drops (approximately 1/2 cc) of each reagent to the surface to be tested. Each reagent (except those marked **) shall be covered with a 1-1/2" diameter watch glass, convex side down to confine the reagent. Spot tests of volatile solvents marked ** shall be tested as follows: A 1" or larger ball of cotton shall be saturated with the solvent and placed on the surfaces to be tested. The cotton ball shall then be covered by an inverted 2-ounce, wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire 24-hour test period and at a temperature of 77 degrees F. + 3 degrees F. At the end of the test period, the reagents shall be flushed from the surfaces with water and the surface scrubbed with a soft bristle brush under running water, rinsed, and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Spots where dyes have dried shall be cleaned with a cotton swab soaked in alcohol to remove the surface dye. The test panel shall then be evaluated immediately after drying.

Rating Description
0 = No Effect: No detectable change in the material surface.
1 = Excellent: Slight detectable change in color or gloss but no change in function or life of the surface.

Rating Description
2 = Good: A clearly discernible change in color or gloss but no significant impairment of surface life or function.
3 = Fair: Objectionable change in appearance due to discoloration or etch, possibly resulting in deterioration of function over an extended period of time.

Chemical Reagent	Rating
Amyl Acetate	1
Ethyl Acetate	0
Acetic Acid, 98%	0
Acetone	1
Acid Dichromate, 5%	2
Butyl Alcohol	0
Ethyl Alcohol	0
Methyl Alcohol	0
Aluminum Hydroxide, 28%	0
Benzene	0
Carbon Tetrachloride	0
Chloroform	1
Chromic Acid, 60%	2
Cresol	1
Dichlor Acetic Acid	1
Dimethylformanide	1
Dioxane	1
Ethyl Ether	1
Formaldehyde, 37%	0
Formic Acid, 90%	1
Furfural	1
Gasoline	0
Hydrochloric Acid, 37%	1
Hydrofluoric Acid, 48%	2
Hydrogen Peroxide, 3%	0
Tincture of Iodine	0
Methyl Ethyl Ketone	1
Methylene Chloride	1
Mono Chlorobenzene	0
Naphthalene	0
Nitric Acid, 20%	0
Nitric Acid, 30%	0
Nitric Acid, 70%	1
Phenol, 90%	1
Phosphoric Acid, 85%	0
Silver Nitrate, Saturated	0
Sodium Hydroxide, 10%	0
Sodium Hydroxide, 20%	0
Sodium Hydroxide, 40%	0
Sodium Hydroxide, Flake	0

Chemical Reagent	Rating
Sodium Sulfide, Saturated	0
Sulfuric Acid, 33%	0
Sulfuric Acid, 77%	0
Sulfuric Acid, 96%	0
Sulfuric Acid, 77% & Nitric Acid, 70%, Equal Parts	1
Toluene	0
Trichloroethylene	0
Xylene	0
Zinc Chloride, Saturated	0

PART 3 INSTALLATION

3.01 INSTALLATION

A. Tops are to be installed only after base cabinets or support systems have been installed, leveled and secured. Tops are to be adhered to cabinets using screws, silicone or 2 part epoxy adhesive-choice dependent upon application. Counter tops are to be installed to achieve a uniform alignment at the front edge of the tops. Overhang of counter top edges are to be consistent and as indicated on approved shop drawings.

B. Shim tops as necessary to produce level joints and seams but no more than 1/8". Joint width is to be consistent through the length of each joint with no gap greater than 1/8". Use 2 part joint epoxy cement mixed per manufacturers recommendations. Prior to setting up, clean and remove excess joint adhesive from counter top and from above joint line. Finished joints should be clean and level with adjacent counter tops. Dips and bumps in joints are not acceptable. Installed tops should be free of uneven surfaces, waves or warping.

C. Installed counter tops are to be protected using heavy gauge paper or cardboard. Each top is to be affixed with a sign warning other trades that finished tops reside below.

D. Manufacturers' protective oil is to remain on countertops after installation and under protective paper and only to be cleaned off by others prior to owner acceptance and move in.

3.02 SINK INSTALLATION

A. The installer responsible for the installation of sinks shall follow good plumbing practice.

B. Sinks to be installed following manufacturer's best recommended practices.

3.03 PLUMBING FIXTURE INSTALLATION

A. The installer responsible for the installation of laboratory service fittings shall follow good plumbing practice.

B. Prior to fixture final connection, plumber to flush supply lines to remove pipe shavings, scale and other debris to eliminate foreign matter from damaging valve components and interfering with the proper operation of fittings.

C. Fittings to be secured to counter tops using manufacturer supplied locknut and lock washer. Do not over tighten.

D. Fixtures are to be installed without scratching the surface finish of faucets, valves or counter tops.

3.04 INSTALLER QUALIFICATIONS

A. Qualified installers shall have 10+ years and $50 million of installed product.

B. Installers shall be directly trained by the epoxy top manufacturer and certified to install epoxy tops to manufacturers recommended practices and tolerances.

3.05 CLEANING

A. Tops are to be cleaned using manufacturers recommended practices;
   1. Clean Kemresin surfaces using a general purpose detergent and warm water.
   2. Apply a coat of linseed oil or furniture polish after cleaning to maintain the top and to hide minor scratches.
   3. Regular applications of linseed oil or furniture polish will enhance the appearance of your work top.

END OF SECTION

SECTION 12 35 53

STEEL LABORATORY CASEWORK

PART 1 DESCRIPTION OF WORK

1.01 SUMMARY AND SCOPE

A. Section Includes:

1. Using Kewaunee Scientific Corporation, RESEARCH COLLECTION Laboratory Furniture as a steel casework specification standard, furnish all cabinets and casework, including tops, ledges, supporting structures, and miscellaneous items of equipment as listed in these specifications, equipment schedules, and drawings. Include delivery to the building, set in place, level, and scribe to walls and floors as required. Furnish and install all filler panels, knee space panels and scribes as shown on drawings.
2. Furnish and deliver all utility service outlet accessory fittings, electrical receptacles and switches as listed in these specifications, equipment schedules, and drawings, as mounted on the laboratory furniture. All plumbing and electrical fittings, not preinstalled in equipment, shall be packaged separately and properly marked for delivery to the appropriate contractor.
3. Furnish and deliver, for installation by the mechanical contractor, all laboratory sinks, cup sinks or drains, drain troughs, overflows and sink outlets with integral tailpieces, which occur above the floor, and where these items are part of the equipment or listed in these specifications, equipment schedules, and drawings. All tailpieces shall be furnished less the couplings required to connect them to the drain piping system.
4. Furnish service strip supports where specified, and set in place, service tunnels, service turrets, supporting structures and reagent racks of the type shown on the drawings.
5. Remove of all debris, dirt and rubbish accumulated as a result of the installation of the laboratory furniture to an onsite container provided by others, leaving the premises broom clean and orderly.

B. Related Divisions:

1. Division 9: Resilient Base
2. Division 22: Plumbing

C. Related Publications:

1. SEFA 3 - Scientific Equipment and Furniture Association
2. SEFA 8 - Scientific Equipment and Furniture Association
3. NFPA 30 - National Fire Protection Association
4. NFPA-45 - National Fire Protection Association
5. UL - Underwriters Laboratories
6. ASTM D522 - Bending Test

1.02 BASIS OF WORK

A. It is the intent of this specification to use Kewaunee Scientific Corporation – RESEARCH COLLECTION Laboratory Furniture as the standard of construction for laboratory furniture. The construction standards of this product line shall provide the basis for quality and functional installation.

B. Supply all equipment in accordance with this specification. The offering of a product differing in materials and construction from this specification requires written approval from the owner/architect. This approval must be obtained seven (7) days before the quotation deadline. Procedures for obtaining approval for an alternate manufacturer are defined in section 1.03.B in this specification.

C. General Contractors should secure a list of approved laboratory furniture manufacturers from the architect as a protection against non-conformance to these specifications.

D. Participants in the quotation process have the option of clarifying deviations to the specified design, construction, or materials. Without such clarifications, sealed quotations to the owner or owner representative will be construed as being in total conformance to the requirements of the specification.

E. The owner/owner's representative reserves the right to reject qualified or alternate proposals and to award based on product value where such action assures the owner greater integrity of product.

1.03 QUALITY ASSURANCE

A. The steel laboratory furniture contractor shall also provide worktops and fume hoods all manufactured or shipped from the same geographic location to assure proper staging, shipment and single source responsibility.

B. General Performance: Provide certification that furniture shall meet the performance requirements described in SEFA 8

C. Finish Performance: Provide independent test lab certification that furniture shall meet the performance requirements described in section 2.05 of these specifications.

1.04 SUBMITTALS

A. Manufacturer's Data: Submit manufacturer's data and installation instructions for each type of casework.

B. Shop Drawings:Submit shop drawings for furniture assemblies showing plans, elevations, ends, cross-sections, service run spaces, location and type of service fittings.
   1. Coordinate shop drawings with other work involved
   2. Provide roughing-in drawings for mechanical and electrical services when required.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The basis of this specification is steel casework manufactured according to the standards used by Kewaunee Scientific Corporation, 2700 Front Street, Statesville, North Carolina. The specified design is Research Collection. All laboratory equipment covered by the specification shall be the product of one manufacturer and be fabricated at one geographic location to assure shipping continuity and single-source responsibility. All quotations from a manufacturer other than Kewaunee Scientific Corporation shall contain a review of the following capabilities:
   1. List of shop facilities
   2. List of engineering and manufacturing personnel

3. Proof of financial ability to fulfill the contract
4. List of a minimum of ten (10) installations over the last five (5) years of comparable scope
5. Proof of project management and installation capabilities
6. SEFA member in Good Standing

B. The selected manufacturer shall warrant that all products be free of defects in material and workmanship for a period of one year. The period shall start at the date of acceptance or occupation, whichever comes first. Purchaser shall notify the manufacturer's representative immediately of any defective product. The manufacturer shall have a reasonable opportunity to inspect the goods. The purchaser shall return no product until receipt by purchaser of written shipping instructions from the manufacturer.

2.02 CABINET MATERIAL:

A. Steel: Cabinet bodies, drawer bodies, shelves, drawer heads and door assemblies shall be fabricated from cold rolled steel.

2.03 DRAWER AND DOOR STYLE:

A. Inset – Square Edge
1. Drawers and doors, when closed, shall be recessed to create an overall flush face with 1/8" reveals. The outer drawer and door head shall have a channel formation on all four sides to eliminate sharp raw edges of steel. The top front corners of the door shall be welded and ground smooth.

2.04 MATERIALS

A. General Requirements:
1. It is the intent of this specification to provide a high-quality steel cabinet specifically designed for the laboratory environment.

B. Steel:
1. Cold Rolled Steel: Cold rolled sheet steel shall be prime grade 12, 14, 16, 18 and 20 gauge U.S. Standard; roller leveled, and shall be treated at the mill to be free of scale, ragged edges, deep scratches or other injurious effects.

C. Hardware and Trim:
1. Drawer and Door Pulls:
   a. Drawer and door pulls shall be mounted on 4" centers, offering a comfortable hand grip, and be securely fastened to doors and drawers.
   b. They shall be manufactured from anodized aluminum in a shallow rounded shape.
2. Hinges:
   a. Inset 5-Knuckle Hinges: Inset style cabinets shall use 5-Knuckle hinges made of Type 304 stainless steel .089 thick, 2-1/2" high, with brushed satin finish, and shall be the institutional type with a five-knuckle bullet-type barrel. Hinges shall be attached to both door and case with two screws through each leaf. Welding of hinges to door or case will not be accepted. Doors under 36" in height shall be hung on one pair of hinges, and doors over 36" in height shall be hung on three hinges. *(Note: meets SEFA 8 specifications)*

3. Drawer Slide:
    a. Heavy duty, full extension, soft-close, self-closing, zinc plated, ball bearing slides, rated for 100 pound loads (See Drawer Assemblies in 2.04, option 1)
4. Shelf Adjustment Clips: Shelf adjustment clips shall be die formed, nickel-plated steel.
5. Base Molding: Base molding shall be provided by others.
6. Sink Supports: Sink supports shall be the hanger type, suspended from end panels of sink cabinet by four 1/4" dia. rods, threaded at bottom end and offset at top to hang from two full-depth reinforcements, welded to the top of end panels. Two 3/4" x 1-1/2" x 12 gauge channels shall be hung on the threaded rods to provide an adjustable sink cradle for supporting sinks.

2.05 CONSTRUCTION

A. Steel Cabinet Construction:
1. General:
    a. The steel furniture shall be of modern design and shall be constructed in accordance with the best practices of the Scientific Laboratory Equipment Industry. First class quality casework shall be insured by the use of proper machinery, tools, dies, fixtures and skilled workmanship to meet the intended quality and quantity for the project.
    b. All cabinet bodies shall be flush front construction with intersection of vertical and horizontal case members, such as end panels, top rails, bottoms and vertical posts in same plane without overlap. Exterior corners shall be spot welded with heavy back up reinforcements.
    c. Each cabinet shall be complete so that units can be relocated at any subsequent time without requiring field application of finished ends or other such parts.
    d. Case openings of Inset style cabinets shall be rabbeted on all four sides for both hinged and sliding doors to provide a dust resistant case.
    e. All cabinets shall have a cleanable smooth interior. Bottoms shall be formed down on sides and back to create easily cleanable corners with no burrs or sharp edges.
    f. Cabinets shall be designed using a standardized grid pattern to allow reconfiguration of doors and drawers.
2. Steel Gauges: Gauges of steel used in construction of cases shall be 18 gauge, except as follows:
    a. Leveling bolt reinforcements 12 gauge.
    b. Top and intermediate front horizontal rails, apron rails, hinge reinforcements, and reinforcement gussets, 16 gauge.
    c. Drawer assemblies, door assemblies, bottom, bottom back rail, toe space rail, and adjustable shelves, 20 gauge.

B. Base Cabinets:
1. End uprights shall be formed into not less than an L formation at top, bottom, back and a 3/4" wide front C formation. A pilaster shall be added to the inside front of the upright for cabinet and hinge reinforcement and shall be perforated for the support of drawer channels, intermediate rails, hinge screws, and shelf adjustment holes.
2. A 7/8" high top horizontal rail shall interlock with the flange at top of end panels for strength, but shall be flush at face of unit. Top rails not flush with face of end uprights are not acceptable.

3. Intermediate rails shall be provided between doors and drawers, but shall not be provided between drawers unless made necessary by locks in drawers. Intermediate rails shall be recessed behind doors and drawer fronts, and designed so that security panels may be added as required.
4. Intermediate vertical uprights shall be furnished to enclose cupboards when used in a unit in combination with a half width bank of drawers.
5. Cabinet bottom shall be formed of one piece of steel, except in corner units, and shall be formed down on sides and back to create a square edge transition welded to cabinet end panels. Front edge shall include a C formation to form a 7/8" high bottom front rail and shall be flush with face of end uprights. Cabinet bottom front rails not flush with face of end uprights are not acceptable.
   Toe space rail shall extend up and forward to engage bottom panel to form a smooth surfaced fully enclosed toe space, 3" deep x 4" high.
6. Back construction shall be one piece with integral channel formed for maximum strength and welded to back of top and bottom flanges of end uprights.
7. Each bottom corner of base cabinets shall have a 3/8"-16 leveling bolt, 2-1/2" long capable of supporting 500 lbs. Access to the leveling bolts shall be through plug buttons in the cabinet bottom. Access to leveling bolts through toe space or leveling bolts requiring special tools to adjust are not acceptable.
8. Adjustable shelves shall be formed down 3/4", returned back 7/8" and up 1/4" into a channel formation front and rear and formed down 3/4" at each end. Shelves over 42" long shall be further reinforced with a channel formation welded to underside of shelf. Shelves shall be adjustable on not more than 1" increments.
9. Steel Door assembly (two-piece) for solid panel swinging doors shall consist of an inner and outer door pan. Outer door pan shall be formed at all four sides. The corners on the pull side of the outer door pan shall be welded and ground smooth to prevent exposure of sharp edges of steel at these critical points. Inner door pan shall be flanged at all four sides with hinge reinforcements welded in place. The door assembly shall be 3/4" thick and contains sound deadening material. Door assemblies shall be painted prior to assembly, and shall be punched for attaching pulls. Inner pan formation of door shall be indented for in-field installation of locks when required.
10. Doors shall be readily removable and hinges easily replaceable. Hinges shall be applied to the cabinet and door with screws. Welding of hinges to either cabinet or door will not be acceptable.
11. Drawer Assemblies:
    a. Drawer bodies shall be made in one-piece construction including the bottom, two sides, back and front. They shall be fully coved at interior bottom on all four sides for easy cleaning. The top front of the inner drawer body shall be offset to interlock with the channel formation in drawer head providing a 3/4" thick drawer head.
12. Knee space panels, where shown or specified, shall be 20 gauge, finished same as casework cabinets, and easily removable for access to mechanical service areas.

C. Special Purpose Storage Cabinets:

1. Acid Storage Fume Hood Cabinets: Acid storage fume hood cabinets shall utilize the same gauges of steel and construction features as other base cabinets except they shall be completely lined with a one piece polyethylene corrosion resistant liner. The liner shall be 1/4" thick, molded into a seamless tub, including top, sides and bottom, with a 1" lip at the bottom front to contain spills. Tubs shall include integral cleats at both ends and back to support an optional shelf. Each door shall have a set of louvers at the top and bottom, and have a 1/8" sheet polyethylene liner. Each cabinet shall be vented with a 1-1/2" vent pipe allowing a positive airflow directly into the laboratory exhaust system.

D. Upper Cabinet Construction:

1. Upper cabinets shall have a completely finished interior same as exterior and shall be designed so that no mounting hardware is visible when installed.
2. End uprights shall be formed at front, bottom and back to provide maximum strength and rigidity. Front edge of end upright shall be 3/4" wide. A pilaster shall be added to the inside front of the upright for cabinet and hinge reinforcement and shall be perforated for hinge screws, and shelf adjustment holes.
3. Cabinet tops shall be formed with a 7/8" high C formation at the front edge and turned down at the back to engage a wall hanging rail.
4. Cabinet flush bottoms shall be formed with a 7/8" high C formation at the front edge.
5. Cabinet false bottoms shall be formed down on all four edges and shall be removable.
6. Cabinet backs shall be welded to the top, bottom and ends. Backs shall be perforated for shelf adjustment holes. Holes shall be enclosed by end uprights.
7. Adjustable shelves shall be formed down 3/4", returned back 7/8" and up 1/4" into a channel formation front and rear, formed down 3/4" at each end. Shelves over 42" long shall be further reinforced with a channel formation welded to underside of shelf. Shelves shall be adjustable on not more than 1" increments.
8. Solid panel doors shall consist of an inner and outer door pan. Outer door pan shall be formed into a channel or flanged shape at all four sides. The corners on the pull side of the outer door pan shall be welded and ground smooth to prevent exposure of sharp edges of steel at these critical points. Inner door pan shall be flanged at all four sides with hinge reinforcements welded in place. The door assembly shall be 3/4" thick and contains sound deadening material.
9. Swinging doors under 36" high shall be hung on one pair of hinges, doors over 36" high shall be hung on three hinges.

2.06 PERFORMANCE REQUIREMENTS

A. Steel Casework Construction Performance:

1. Base cabinets shall be constructed to support at least a uniformly distributed load 200 pounds per square foot of cabinet top area, including working surface without objectionable distortion of interference with door and drawer operation.
2. Base cabinet leveling bolts shall support 500 pounds per corner, at 1-1/2" projection of the leveling bolt below the cabinet bottom.
3. Each adjustable and fixed shelf 4 feet or shorter in length shall support an evenly distributed load of 40 pounds per square foot up to a maximum of 200 pounds, with nominal temporary deflection, but without permanent set.
4. Full extension soft-close, self-closing ball bearing zinc plated drawer slide shall be rated for 100 pound loads.

5. Swinging doors on floor-mounted inset style casework shall support 200 pounds suspended at a point 12" from hinged side, with door swung through an arc of 160 degrees. Weight load test shall allow only a temporary deflection, without permanent distortion or twist. Door shall operate freely after test and assume a flat plane in a closed position.

B. Steel Paint System Finish and Performance Specification:

1. Steel Paint System Finish:

   a. After Cold Rolled Steel and Textured Steel component parts have been completely welded together and before finishing, they shall be given a pre-paint treatment to provide excellent adhesion of the finish system to the steel and to aid in the prevention of corrosion. Physical and chemical cleaning of the steel shall be accomplished by washing with an alkaline cleaner, followed by a spray treatment with a complex metallic phosphate solution to provide a uniform fine grained crystalline phosphate surface that shall provide both an excellent bond for the finish and enhance the protection provided by the finish against humidity and corrosive chemicals.

   b. After the phosphate treatment, the steel shall be dried and all steel surfaces shall be coated with a chemical and corrosion-resistant, environmentally friendly, electrostatically applied powder coat finish. All components shall be individually painted, insuring that no area be vulnerable to corrosion due to lack of paint coverage. The coating shall then be cured by baking at elevated temperatures to provide maximum properties of corrosion and wear resistance.

   c. The completed finish system in standard colors shall meet the performance test requirements specified under PERFORMANCE TEST RESULTS.

2. Performance Test Results (Chemical Spot Tests):

   a. Testing Procedure: Chemical spot tests for non-volatile chemicals shall be made by applying 5 drops of each reagent to the surface to be tested and covering with a 1-1/4" dia. watch glass, convex side down to confine the reagent. Spot tests of volatile chemicals shall be tested by placing a cotton ball saturated with reagent on the surface to be tested and covering with an inverted 2-ounce wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire test period, and at a temperature of 77° ±3° F. For both methods, leave the reagents on the panel for a period of one hour. At the end of the test period, the reagents shall be flushed from the surface with water, and the surface scrubbed with a soft bristle brush under running water, rinsed and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Immediately prior to evaluation, 16 to 24 hours after the reagents are removed, the test surface shall be scrubbed with a damp paper towel and dried with paper towels.

   b. Test Evaluation: Evaluation shall be based on the following rating system.

Level 0	No detectable change.
Level 1	Slight change in color or gloss.
Level 2	Slight surface etching or severe staining.
Level 3	Pitting, cratering, swelling, or erosion of coating. Obvious and significant deterioration.

After testing, panel shall show no more than three (3) Level 3 conditions.

c. Test Reagents

Test No.	Chemical Reagent	Test Method
1	Acetate, Amyl	Cotton ball & bottle
2	Acetate, Ethyl	Cotton ball & bottle
3	Acetic Acid, 98%	Watch glass
4	Acetone	Cotton ball & bottle
5	Acid Dichromate, 5%	Watch glass
6	Alcohol, Butyl	Cotton ball & bottle
7	Alcohol, Ethyl	Cotton ball & bottle
8	Alcohol, Methyl	Cotton ball & bottle
9	Ammonium Hydroxide, 28%	Watch glass
10	Benzene	Cotton ball & bottle
11	Carbon Tetrachloride	Cotton ball & bottle
12	Chloroform	Cotton ball & bottle
13	Chromic Acid, 60%	Watch glass
14	Cresol	Cotton ball & bottle
15	Dichlor Acetic Acid	Cotton ball & bottle
16	Dimethylformanide	Cotton ball & bottle
17	Dioxane	Cotton ball & bottle
18	Ethyl Ether	Cotton ball & bottle
19	Formaldehyde, 37%	Cotton ball & bottle
20	Formic Acid, 90%	Watch glass
21	Furfural	Cotton ball & bottle
22	Gasoline	Cotton ball & bottle
23	Hydrochloric Acid, 37%	Watch glass
24	Hydrofluoric Acid, 48%	Watch glass
25	Hydrogen Peroxide, 3%	Watch glass
26	Iodine, Tincture of	Watch glass
27	Methyl Ethyl Ketone	Cotton ball & bottle
28	Methylene Cloride	Cotton ball & bottle
29	Mono Chlorobenzene	Cotton ball & bottle
30	Naphthalene	Cotton ball & bottle
31	Nitric Acid, 20%	Watch glass
32	Nitric Acid, 30%	Watch glass
33	Nitric Acid, 70%	Watch glass
34	Phenol, 90%	Cotton ball & bottle
35	Phosphoric Acid, 85%	Watch glass
36	Silver Nitrate, Saturated	Watch glass
37	Sodium Hydroxide, 10%	Watch glass
38	Sodium Hydroxide, 20%	Watch glass
39	Sodium Hydroxide, 40%	Watch glass
40	Sodium Hydroxide, Flake	Watch glass
41	Sodium Sulfide, Saturated	Watch glass
42	Sulfuric Acid, 33%	Watch glass
43	Sulfuric Acid, 77%	Watch glass
44	Sulfuric Acid, 96%	Watch glass

Test No.	Chemical Reagent	Test Method
45	Sulfuric Acid, 77% and Nitric Acid, 70%, equal parts	Watch glass
46	Toluene	Cotton ball & bottle
47	Trichloroethylene	Cotton ball & bottle
48	Xylene	Cotton ball & bottle
49	Zinc Chloride, Saturated	Watch glass

** Where concentrations are indicated, percentages are by weight.*

3. Performance Test Results (Heat Resistance):
   a. Hot water (190° F - 205° F) shall be allowed to trickle (with a steady stream at a rate not less than 6 ounces per minute) on the finished surface, which shall be set at an angle of 45° from horizontal, for a period of five minutes. After cooling and wiping dry, the finish shall show no visible effect from the hot water treatment.
4. Performance Test Results (Impact Resistance):
   a. A one-pound ball (approximately 2" diameter) shall be dropped from a distance of 12 inches onto the finished surface of steel panel supported underneath by a solid surface. There shall be no evidence of cracks or checks in the finish due to impact upon close eye-ball examination.
5. Performance Test Results (Bending Test):
   a. An 18 gauge steel strip, finished as specified, when bent 180^{o} over a 1/2" diameter mandrel, shall show no peeling or flaking off of the finish.
6. Performance Test Results (Adhesion):
   a. Ninety or more squares of the test sample shall remain coated after the scratch adhesion test. Two sets of eleven parallel lines 1/16" apart shall be cut with a razor blade to intersect at right angle thus forming a grid of 100 squares. The cuts shall be made just deep enough to go through the coating, but not into the substrate. They shall then be brushed lightly with a soft brush. Examine under 100 foot-candles of illumination. Note: This test is based on ASTM D2197-68, "Standard Method of Test for Adhesion of Organic Coatings".
7. Performance Test Results (Hardness):
   a. The test sample shall have a hardness of 4-H using the pencil hardness test. Pencils, regardless of their brand are valued in this way: 8-H is the hardest, and next in order of diminishing hardness are 7-H, 6-H, 5-H, 4-H, 3-H, 2-H, F, HB, B (soft), 2-B, 3-B, 4-B, 5-B (which is the softest).
   b. The pencils shall be sharpened on emery paper to a wide sharp edge. Pencils of increasing hardness shall be pushed across the paint film in a chisel-like manner until one is found that will cut or scratch the film. The pencil used before that one, that is, the hardest pencil that will not rupture the film, is then used to express or designate the hardness.

PART 3 EXECUTION

3.01 SITE EXAMINATION

A. The owner and/or his representative shall assure all building conditions conducive to the installation of a finished goods product; all critical dimensions and conditions previously checked have been adhered to by other contractors (general, mechanical, electrical, etc.) to assure a quality installation.

3.02 INSTALLATION

A. Preparation:
   1. Prior to beginning installation of casework, check and verify that no irregularities exist that would affect quality of execution of work specified.

B. Coordination:
   1. Coordinate the work of the Section with the schedule and other requirements of other work being prepared in the area at the same time both with regard to mechanical and electrical connections to and in the fume hoods and the general construction work.

C. Performance:
   1. Casework:
      a. Set casework components plumb, square, and straight with no distortion and securely anchor to building structure. Shim as required using concealed shims.
      b. Bolt continuous cabinets together with joints flush, tight and uniform, and with alignment of adjacent units within 1/16" tolerance.
      c. Secure wall cabinets to solid supporting material, not to plaster, lath or gypsum board.
      d. Abut top edge surfaces in one true plane. Provide flush joints not to exceed 1/8".
   2. Worksurfaces:
      a. Where required due to field conditions, scribe to abutting surfaces.
      b. Only factory prepared field joints, located per approved shop drawings, shall be permitted. Secure the joints in the field, where practical, in the same manner as in the factory.
      c. Secure worksurfaces to casework and equipment components with materials and procedures recommended by the manufacturer.

D. Adjust and Clean:
   1. Repair or remove and replace defective work, as directed by owner and/or his representative upon completion of installation.
   2. Adjust doors, drawers and other moving or operating parts to function smoothly.
   3. Clean shop finished casework; touch up as required.
   4. Clean worksurfaces and leave them free of all grease and streaks.
   5. Casework to be left broom clean and orderly.

E. Protection:
   1. Provide reasonable protective measures to prevent casework and equipment from being exposed to other construction activity.
   2. Advise owner and/or his representative of procedures and precautions for protection of material, installed laboratory casework and fixtures from damage by work of other trades.

END OF SECTION

SECTION 22 01 00

GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 GENERAL

A. General Conditions and Division 01 apply to this Division.

1.02 SCOPE

A. Includes -
   1. Furnish all labor, materials, and equipment necessary for the completion of the mechanical and plumbing scope of work.
   2. Furnish and install all motors specified in this Division and be responsible for the proper operation of electrical powered equipment furnished by this Division.
   3. Furnish exact location of electrical connections and information on motor controls to Division 26.
   4. Mechanical Contractor shall obtain the services of independent Test and Balance Agency.
   5. Placing the air conditioning, heating, ventilating, and exhaust systems into full operation and continuing their operation during each working day of testing and balancing.
   6. Making changes in pulleys, belts, and dampers, or adding dampers, as required for the correct balance as recommended by Balancing Contractor at no additional cost to Owner.
   7. Air balance, final adjustment and test run.
   8. The satisfactory performance of the completed systems is a requirement of this specification.

B. Related Work Specified Elsewhere
   1. Conduit, line voltage wiring, outlets, and disconnect switches specified in Division 26.
   2. Magnetic starters and thermal protective devices (heaters) not a factory mounted integral part of packaged equipment are specified in Division 26.

1.03 SITE OBSERVATION

A. The Contractor shall examine the site and understand the conditions which may affect the performance of work of this Division before submitting proposals for this work.

B. No subsequent allowance for time or money will be considered for any consequence related to failure to examine existing site conditions.

1.04 DRAWINGS

A. Mechanical drawings show general arrangement of piping, ductwork, equipment, etc; however, locations are to be regarded as shown diagrammatically only. Follow as closely as actual building construction and work of other trades will permit.

B. Because of the small scale of mechanical drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Investigate existing structural and finished conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions.

1. If changes in location of piping, equipment, ducts, etc. are required due to lack of coordination of work under this division, such changes shall be made without charge. Contractor shall review drawings with local and state agencies having jurisdiction and any changes required by them shall be brought to the attention of the Engineer prior to bidding or commencement of work. It is understood that while Drawings are to be followed as closely as circumstances permit, this Division will be held responsible for the installation of systems according to the true intent and meaning of the Contract Documents. Anything not clear or in conflict will be explained by making application to the Engineer in writing. Should conditions arise where certain changes would be advisable, secure Owner's and Engineer approval for these changes before proceeding with work.

1.05 COORDINATION OF WORK:

A. Coordinate work of various trades in installing interrelated work. Before installation of mechanical items, make proper provision to avoid interferences in a manner approved by Engineer. Changes required in work specified in Division 22 and 23 caused by neglect to secure approval shall be made at no cost to Owner.

B. Arrange piping, ductwork, and equipment to permit ready access to valves, unions, starters, motors, control components, and to clear openings of doors and access panels. Contractor shall provide all necessary access doors and/or panels to provide complete access to all mechanical equipment, dampers, or accessories. Doors for dampers, etc. shall be minimum 12" x 12" and doors for mechanical equipment shall be minimum 24" x 24".

C. Furnish and install inserts and supports required by Division 22 and 23 unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions involved in sufficient time to be built into the construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne by Contractor.

D. Be responsible for required digging, cutting, and patching incident to work of this Division and make required repairs afterwards to satisfaction of Owner and Architect. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses.

1. Patch and repair walls, floors and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
2. This Division shall bear expense of cutting, patching, repairing, and replacing of work of other Divisions because of its fault, error, tardiness, or because of damage done by it.
3. Provide the necessary cutting, patching, repairing, and replacing pavements, sidewalks, etc. to permit installation of work of this Division.

E. Adjust locations of piping, ductwork, equipment, etc, to accommodate work from interferences anticipated and encountered. Determine exact route and location of each pipe and cut prior to fabrication.

1. Make offsets, transitions, and changes in direction of piping, ductwork, and electrical raceways as required to maintain proper head room and pitch of sloping lines whether or not indicated on Drawings.

F. Slots and openings through floors, walls and roofs shall be provided by this Division.

G. This Contractor shall schedule his work, store his equipment and materials, and work in harmony with other Contractors so as to not delay or jeopardize the construction.

H. This Division shall coordinate with electrical contractor to insure that all required components of control work are included and fully understood. Any discrepancies shall be called to the attention of the Engineer before completion of bids. No additional cost shall accrue to the Owner as a result of lack of such coordination.

1.06 EQUIPMENT & MATERIALS:

A. Requests for substitution shall be received in writing a minimum of seven days prior to bidding. Prior acceptance shall be by Manufacturer's name only. Items not listed in this specification or subsequent addendums shall not be considered. No oral approvals will be acceptable. Manufacturers listed in this specification are acceptable only for items listed. All other items manufacturer wishes to bid must be prior approved. All equipment shall be subject to final review in accordance with "Project Submittals".

B. Product Approvals -

1. If approval is received to use other than specified items, responsibility for specified capacities and insuring that items to be furnished will fit space available lies with this Division.
2. In the event other than specified equipment is used and will not fit job site conditions, this Division assumes responsibility for replacement with items named in Specification.

C. Use <u>domestic made</u> pipe, pipe fittings, and motors on Project.

D. Motor and equipment name plates as well as applicable UL labels shall be in place when Project is turned over to Owner.

E. Insure that items to be furnished fit spaces available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents. Do not scale off drawings.

F. All materials shall be of the best commercial quality obtainable, consistent with specified materials and for the purpose or function intended. Materials shall be new unless specifically excepted.

G. Equipment catalog or model numbers shown define the basic equipment types and quality standard only. Catalog numbers shall not be considered as all inclusive and shall be verified to include all devices, controls, operators, and appurtenances necessary for the satisfactory and complete operation of the equipment.

H. Follow manufacturer's directions in delivery, storage, protection, and installation of equipment and materials.
   1. Promptly notify Engineer in writing of conflicts between requirements of Contract Documents and Manufacturer's directions and obtain Engineer's written instructions before proceeding with work. Contractor shall bear all expenses arising from correcting deficiencies of work that does not comply with Manufacturer's directions or such written instructions.

I. Deliver equipment and material to site and tightly cover and protect against dirt, water, and chemical or mechanical injury but have readily accessible for inspection. Store items subject to moisture damage (such as controls) in a dry, heated space.

1.07 PROJECT SUBMITTALS:

A. Provide submittals per Division 01 33 00 Submittal Procedures

B. Submittal shall include, but not be limited to the following:
   1. equipment scheduled
   2. balancing contractor
   3. insulation
   4. grilles, and diffusers
   5. automatic temperature controls
   6. certificates of guarantee
   7. valves
   8. plumbing fixtures, accessories, and specialties
   9. any item for which more than one manufacturer is mentioned

C. If material or equipment is not as specified or submittal is not complete, it will be rejected.

D. Catalog data or shop drawings for equipment which are noted as approved shall not supersede Contract Documents.

E. Review comments shall not relieve this Division from responsibility for deviations from Contract Documents unless attention has been called to such deviations in writing at time of submission, nor shall they relieve this Division from responsibility for errors in items submitted.

F. Check work described by catalog data with Contract Documents for deviations and errors.

G. All items other than first named specified equipment shall show and state all exceptions and deviations taken and shall include design calculations and drawing layouts.

H. Contractor shall verify equipment dimensions to fit the spaces provided with sufficient clearance for servicing the equipment.

I. Contractor shall review equipment submittals for compliance with schedules, specifications, and drawing plans and details. Equipment submittal shall show the proper arrangements to suit installation and maintenance such as motor location, access doors, filter removal, piping connections, etc.

J. Equipment submittal sheets shall be clearly marked indicating equipment symbol and exact selection of proposed equipment. Submittals shall clearly indicate name of manufacturer of each item.

1.08 CLEANING & FINISHING:

A. Contractor shall, at all times, keep the premises free from waste material and rubbish. Upon completion of this Section of the work, Contractor shall remove all surplus materials and rubbish; clean all spots resulting from the mechanical work from hardware, floors, glass, walls, etc.; do all required patching up and repair all work of other trades damaged by Contractor under this Section of the work, and leave the premises in a clean orderly condition. Clean heating and cooling coils, internally and externally, and replace all air filters prior to final mechanical inspection. Remove rust, plaster, dirt, grease and oil before painting, insulating, or exposing to view the equipment, piping, ductwork, etc. in completed structure. Refinish any damaged surfaces and leave in proper working order at final completion.

1.09 EQUIPMENT SERVICING:

A. Prior to starting mechanical equipment, all motors, bearings and moving parts shall be properly oiled, greased and lubricated as required. Full and adequate maintenance service shall be given and upon completion all equipment shall be cleaned and checked and placed in perfect condition for the Owner.

B. Amount and type of lubricant shall be per manufacturer's specification.

1.10 SUPERVISION:

A. The Contractor shall supervise and direct the work with his best skill and attention. He will be solely responsible for the means, methods, techniques, sequences and procedures of construction. The Contractor will be responsible to see that the finished work complies accurately with the Contract Documents.

1.11 SAFETY REGULATIONS:

A. Contractor shall provide equipment, supervision, construction, procedures, and everything necessary to assure safety of life or property.

B. Refer also to General Condition and Special Conditions for protection clauses.

1.12 LEAK DAMAGE:

A. Contractor shall be responsible for damages to the work of other Contractors or to the building, or to its contents, people, etc., caused by leaks in any of the equipment or piping installed by him through equipment or material failures, leaking joints or disconnected pipes, fittings, or by overflows and shall make at his own expense all repairs to fixtures, building interior, contents, paint, rugs, furniture, ceiling tile, and equipment so damaged.

1.13 TOOLS AND STORAGE OF EQUIPMENT:

A. The Contractor shall furnish all necessary tools, staging and whatever may be necessary for the installation of this work and shall at all times protect this work and others, and the materials to be used therein from damage by the weather, accident and other causes, and shall repair and make good any damage thus occurring.

1.14 WORKMANSHIP:

A. Workmanship shall be the best quality of its kind for respective industries, trades, crafts and practices and shall be acceptable in every respect to the Owner and Engineer. Nothing contained herein shall relieve the Contractor from performing good work, perfect in all details of construction.

1.15 TEMPORARY FACILITIES:

A. Furnishing of temporary water, space heating, sanitary facilities, drainage lines, light and power will be as specified in Division 01 General Conditions. Contractor shall arrange to bring facilities to required location of premises. All expenses involved shall be paid by the Contractor as described in General and Special Conditions.

1.16 PAINTING BY CONTRACTOR:

A. All exposed, insulated, and bare piping, equipment, metal stands and supports shall be painted as follows:
   1. All equipment which is to be furnished in finished painted condition by Contractor shall be left without mark, scratch or impairment to finish upon completion and acceptance of job. Any necessary refinishing to match original shall be done by Contractor. Do not paint over name plates, serial numbers or other identifying marks.

1.17 BELT GUARDS:

A. Shall be provided, properly enclosing each belt drive system. Guards shall be easily removable, constructed of expanded metal with suitable frames corresponding with SMACNA standard and with tachometer openings. Coordinate with equipment suppliers to avoid duplication of belt guards supplied with equipment. Guards shall comply with OSHA Regulations.

1.18 ELECTRICAL WORK:

A. Power wiring to all electrically driven apparatus shall be done under the electrical contract. See Electrical Specifications.

B. Unless specifically noted otherwise on documents, Electrical Contractor shall furnish and install all magnetic starters including properly sized heaters, and disconnect switches as indicated on drawings or required by code.

C. The Contractor shall verify the proper operation of equipment furnished by him. Costs for repair, replacing, re-wiring and retesting shall be borne by the Contractor without additional costs to the Owner.

D. Motors shall be as specified.

1.19 CONTRACTOR'S USE OF BUILDING EQUIPMENT:

A. The Contractor may use equipment such as electric motors, fans, filters, etc. when permanently installed as part of the project and with the written permission of the Owner. As each piece of equipment is used, maintenance procedures approved by the manufacturer shall be followed, a careful record shall be kept of the time used, maintenance procedure following and of any difficulty experienced with equipment. The Contractor's records on the equipment shall be submitted to the Owner upon acceptance of project. All fan belts and filter media shall be new at the beginning of the Mechanical System Operating Test Run and System Balancing. Wearing surfaces (such as bearings) shall be carefully inspected just prior to acceptance. Any excessive wear noted shall require replacement.

1.20 INSPECTION NOTICE:

A. The following is a basic list of guideline items so that the Architect, district building inspector/Owner’s representative can be at job site for these inspections as the building progresses. Mechanical Contractor shall inform these people one week in advance of test time.
   1. Water tests on all sewer, waste, and rainwater piping prior to piping being concealed.
   2. Pressure tests on all water service piping.
   3. Pressure tests on hot, chilled, and condenser water supply and return piping.
   4. All duct work prior to installation of finished ceilings, including ductwork pressure testing.
   5. The initial start-up of mechanical equipment, etc.
   6. Any changes or problems occurring at job site.
   7. Inspect all vent flashings on roof prior to roofing.
   8. Periodic inspection at their discretion will be made to insure compliance to Contract Documents and codes. Contractor shall provide ladders, access and other assistance as requested during inspections.
   9. Control piping pressure tests.
   10. Final inspection before giving approval for final payment.

1.21 EXCAVATION AND BACKFILLING:

A. Trench for the underground gas pipe line shall be excavated to the required depth. Rocks, trash, or other debris will not be allowed in trench or backfill and shall be removed before pipe is laid in place. After piping has been tested, inspected and approved, piping shall be backfilled. All landscaping, concrete, etc., damaged by this Contractor shall be replaced by him to the satisfaction of Owner's Representative.

1.22 WARRANTY GUARANTEE:

A. The Contractor shall warrant all materials and equipment to be of quality consistent with specifications Division 01.

B. Substantial completion and acceptance in no way relieves the Contractor from providing the systems and equipment as specified.

1.23 COMPLETION SCHEDULE:

A. Start-up and verification of basic equipment items shall be done prior to the date of substantial completion with sufficient time to allow balancing and adjusting to be performed.

B. At the time of the final inspection a date shall be agreed upon for completion of any remaining items. At least double the estimated cost of the work will be withheld from the Contractor's payment.

1.24 CODE REQUIREMENTS, FEES, AND PERMITS

A. The work shall be installed in accordance with the following applicable codes, ordinances and standards unless otherwise specified. The codes and standards shall include but not be limited to and be of the latest and current editions.
   1. American Boiler and Affiliated Industries (AB and AI)
   2. American Gas Association (AGA)
   3. Air Movement and Control Association (AMCA)
   4. American National Standards Institute (ANSI)
   5. Air Conditioning & Refrigeration Institute (ARI)
   6. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) - ASHRAE 90.1-2019
   7. American Society of Mechanical Engineers (ASME)
   8. American Society of Testing Materials (ASTM)
   9. American Standards Association (ASA)
   10. American Water Works Association (AWWA)
   11. American Welding Society (AWS)
   12. Associated Air Balance Council (AABC)
   13. Heat Exchange Institute (HEI)
   14. Hydraulic Institute (HI)
   15. BR
   16. National Electrical Code (NEC)

17. National Fire Protection Association (NFPA)
18. Sheet Metal and Air Conditioning contractors National Association (SMACNA)
19. Underwriters Laboratories (UL)
20. International Building Code (IBC) 2021 Ed
21. International Mechanical Code (IMC) 2021 Ed
22. International Plumbing Code (IPC) with local AHJ Amendments 2021 Ed
23. International Energy Conservation Code (IECC) 2021 Ed
24. ASHRAE Ventilation STD.62-2019

B. Should drawings conflict with any code, the code shall govern. If drawings and specifications establish a quality exceeding the code, the drawings and specifications shall govern. If conflicts do exist among the drawings, specifications and codes, the same shall be brought to the attention of the Engineer in writing prior to bidding, otherwise Contractor shall comply with applicable codes.

C. The latest edition of all codes shall be used.

D. Contractor shall give all notices, obtain all necessary permits, file necessary plans, prepare documents and obtain approvals, and pay all fees required for completion of the mechanical and plumbing work outlined in this Division of the specifications and shown on the Mechanical Drawings.

1.25 OPERATION AND MAINTENANCE MANUAL FOR MECHANICAL SYSTEMS

A. Upon completion of work provide operation and maintenance manuals per Section 01 78 23 Operation and Maintenance Data.

1.26 OPERATION AND MAINTENANCE INSTRUCTIONS

A. Contractor shall instruct building maintenance personnel in the operation and maintenance of the installed mechanical systems per Division 01

B. Minimum instruction periods shall be as follows -
   1. Mechanical hVAC - Four hours.
   2. Temperature Control - Four hours.

C. Instruction periods shall occur before final site observation when systems are properly working and before final payment is made.

D. None of these instructional periods shall overlap each other.

E. An additional two hours of instruction will be provided by each contractor, after 60 days of system operation by owner to insure proper system operation and answer questions.

1.27 RECORD DRAWINGS

A. Contractor shall keep an up-to-date set of mechanical and plumbing redlines drawings per Section 01 78 39 Project Record Documents.

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

(Not Used)

END OF SECTION

SECTION 22 05 00

BASIC PLUMBING AND HVAC MATERIALS AND METHODS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Sleeves.
   5. Escutcheons.
   6. Mechanical demolition.
   7. Equipment installation requirements common to equipment sections.

1.03 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
   1. ABS: Acrylonitrile-butadiene-styrene plastic.
   2. CPVC: Chlorinated polyvinyl chloride plastic.
   3. PVC: Polyvinyl chloride plastic.

1.04 SUBMITTALS

A. Product Data: For the following:
   1. Dielectric fittings.
   2. Mechanical sleeve seals.

B. Welding certificates.

1.05 QUALITY ASSURANCE

A. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

B. All materials, piping, etc. shall be new, and domestically made of the best commercial quality obtainable, consistent with specified materials and for the purpose or function intended unless specifically approved in writing prior to bid.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.07 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

PART 2 PRODUCTS

2.01 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 and 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.02 JOINING MATERIALS

A. Refer to individual Division 22 and 23 piping Sections for special joining materials not listed below.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Solvent Cements for Joining Plastic Piping:
   1. ABS Piping: ASTM D 2235.
   2. CPVC Piping: ASTM F 493.
   3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
   4. PVC to ABS Piping Transition: ASTM D 3138.

2.03 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

   1. Available Manufacturers:

      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Eclipse, Inc.
      d. Epco Sales, Inc.
      e. Hart Industries, International, Inc.
      f. Watts Industries, Inc.; Water Products Div.
      g. Zurn Industries, Inc.; Wilkins Div.
      h. Prior Approved Equal.

2.04 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Available Manufacturers:
      i. Advance Products & Systems, Inc.
      j. Calpico, Inc.
      k. Metraflex Co.
      l. Pipeline Seal and Insulator, Inc.
      m. Linkseal.
      n. Prior Approved Equal.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Carbon steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.05 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

E. PVC Pipe: ASTM D 1785, Schedule 40.

2.06 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

2.07 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 MECHANICAL DEMOLITION

A. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
   3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
   4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
   5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

B. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

C. Coordinate with controls contractor prior to removal of any control devices.

3.02 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 and 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Drawings do not show every offset, or bend that may be required. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors where indicated on drawings and where penetrating will be visible to public.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

Q. Verify final equipment locations for roughing-in.

R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.03 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 and 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
   3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
   5. PVC Nonpressure Piping: Join according to ASTM D 2855.
   6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

I. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.04 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.05 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

END OF SECTION

SECTION 22 05 23

GENERAL- DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following general-duty valves:
   1. Bronze ball valves.
   2. Bronze check valves.

B. Related Sections include the following:
   1. Division 22 and 23 Section "Mechanical Identification" for valve tags and charts.
   2. Division 22 and 23 Section "HVAC Instrumentation and Controls" for control valves and actuators.
   3. Division 22 and 23 piping Sections for specialty valves applicable to those Sections only.

1.03 DEFINITIONS

A. The following are standard abbreviations for valves:
   1. CWP: Cold working pressure.
   2. EPDM: Ethylene-propylene-diene terpolymer rubber.
   3. NRS: Nonrising stem.
   4. OS&Y: Outside screw and yoke.
   5. PTFE: Polytetrafluoroethylene plastic.
   6. SWP: Steam working pressure.
   7. TFE: Tetrafluoroethylene plastic.

1.04 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.05 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 for building services piping valves.
   1. Exceptions: Domestic hot- and cold-water piping valves unless referenced.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

C. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.

D. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.

E. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

G. Valve Actuators:
   1. Handwheel: For valves other than quarter-turn types.

2. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
3. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.

H. Valves in Insulated Piping: Valves shall have 2-inch stem extensions and the following features:
1. Ball Valves: Shall have extended operating handle of non-thermal-conductive material, protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation, and memory stops that are fully adjustable after insulation is applied.
a. Manufactures: NIBCO Nib-seal handle extension or a comparable product by one of the following:
1) Conbraco Industries, Inc.; Apollo Div.
2) American.
3) Crane.
4) Grinnel.
5) Kitz.
6) Watts.
7) Prior approved equal.
2. Butterfly Valves: Shall have extended necks.

I. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

J. Valve Grooved Ends: AWWA C606.

K. Solder Joint: With sockets according to ASME B16.18.
1. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.

L. Threaded: With threads according to ASME B1.20.1.

M. Valve Bypass and Drain Connections: MSS SP-45.

2.03 BRONZE BALL VALVES

A. Bronze Ball Valves, General: MSS SP-110 and have bronze body complying with ASTM B 584, except for Class 250 which shall comply with ASTM B 61, full-depth ASME B1.20.1 threaded or solder ends, and blowout-proof stems.

B. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: Chrome-plated bronze ball and bronze stem and; reinforced TFE seats; threaded body packnut design (no threaded stem designs allowed) with adjustable stem packing, solder or threaded ends; and 150 psig SWP 600-psigCWP rating.
1. Manufacturers: NIBCO Model S-585-70 or T-585-70, or a comparable product by one of the following:
a. NIBCO Model S-585-70 or T-585-70
b. American Valve, Inc.

c. Conbraco Industries, Inc.; Apollo Div.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Div.
f. Grinnell Corporation.
g. Kitz Corporation of America.
h. NIBCO INC.
i. Watts Industries, Inc.; Water Products Div.

C. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel vented ball and stem, reinforced TFE seats, threaded body packnut design (no threaded stem designs allowed) with adjustable stem packing, soldered or threaded ends; 150 psig SWP and 600-psig CWP ratings.
1. Manufacturers: NIBCO Model S-585-70-66 or T-585-70-66, or a comparable product by one of the following:
a. Conbraco Industries, Inc.; Apollo Div.
b. American Valve, Inc.
c. Conbraco Industries, Inc.; Apollo Div.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Div.
f. Grinnell Corporation.
g. Kitz Corporation of America.
h. NIBCO INC.
i. Watts Industries, Inc.; Water Products Div.

2.04 BRONZE CHECK VALVES

A. Bronze Check Valves, General: MSS SP-80.

B. Class 125, Bronze, Lift Check Valves with TFE Disc: ASTM B-584 bronze body and integral seat with soldered or threaded end connections, and having 250-psig CWP rating.
1. Manufacturers: NIBCO Model S-480-Y or T-480-Y, or a comparable product by one of the following:
a. Cincinnati Valve Co.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Stockham Div.
d. Red-White Valve Corp.
e. Walworth Co.

C. Class 125, Bronze, Lift Check Valves with BUNA Disc: ASTM B-584 bronze body and integral seat with nonmetallic BUNA disc, soldered or threaded end connections, and having 250-psig CWP rating.
1. Manufacturers: NIBCO Model S-480 or T-480, or a comparable product by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Powell, Wm. Co.

D. Class 125, Bronze, Swing Check Valves with TFE Disc: ASTM B-62 bronze body and seat with TFE disc in bronze seat holder, Y-pattern design, soldered or threaded end connections, and having 200 psig CWP rating.
   1. Manufacturers: NIBCO Model S-413-Y or T-413-Y, or a comparable product by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Powell, Wm. Co.

E. Class 125, Bronze, Swing Check Valves with BUNA Disc: ASTM B-62 bronze body and seat with BUNA disc in bronze seat holder, Y-pattern design, soldered or threaded end connections, and having 200 psig CWP rating.
   1. Manufacturers: NIBCO Model S-413-W or T-413-W, or a comparable product by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Powell, Wm. Co.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball or butterfly valves.
   2. Throttling Service: Angle, ball, butterfly, or globe valves.
   3. Pump Discharge: Spring-loaded, lift-disc or dual-plate check valves; lever and weight swing check valves; or lever and spring swing check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

C. Domestic Water Piping: Use the following types of valves:
   1. Ball Valves, NPS 2 and Smaller: Two -piece, full port, stainless-steel trim, bronze.
   2. Ball Valves, NPS 2-1/2 and Larger: Class 150, full -port, ferrous alloy.
   3. Butterfly Valves, NPS 2 to NPS 12 Single-flange, full lug, 200-psig CWP rating, bronze disc, EPDM liner, ferrous alloy.
   4. Lift Check Valves, NPS 2 and Smaller: Class 125 , bronze with TFE disc.

D. Select valves, except wafer and flangeless types, with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for heating hot water.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends.

3.03 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe. Butterfly valves may be installed with stem horizontal to allow support for the disc and the cleaning action of the disc.

E. Install valves in position to allow full stem movement.

F. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
   3. Lift Check Valves: With stem upright and plumb.

G. Butterfly valves shall be installed with stems horizontal.

3.04 JOINT CONSTRUCTION

A. Refer to Division 22 and 23 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.05 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION

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SECTION 22 05 48

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:
   1. Isolation pads.
   2. Freestanding and restrained spring isolators.
   3. Seismic snubbers.
   4. Restraining braces and cables.

1.03 SCOPE

A. Provide letter of design intent.

B. Provide full set of seismic submittals.

C. Provide final letter of compliance completion.

1.04 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

1.05 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:
   1. Basic Wind Speed: Per owner's design standards.
   2. Building Classification Category: As defined in the IBC.
   3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

B. Seismic-Restraint Loading:
   1. Site Class: As defined in the IBC.
   2. Assigned Seismic Use Group or Building Category: As defined in the IBC.
      a. Component Importance Factor: 1.5.

1.06 SUBMITTALS

A. Product Data: For the following:
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.
   3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Letter of Design intent, stating company, design criteria, compliance with specifications and only exceptions that will apply. Letter shall be stamped and signed by a licensed and qualified professional engineer in this jurisdiction.

C. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.
      a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 22 and 23 Sections for equipment mounted outdoors.
   2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
   3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
   4. Seismic- and Wind-Restraint Details:
      a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
      b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacing's. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
      c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 22 and 23 Sections for equipment mounted outdoors.

d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

D. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

E. Welding certificates.

F. Qualification Data: For professional engineer and testing agency.

G. Field quality-control test reports.

1.07 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

E. Upon project completion provide a final letter of acceptance for seismic restraints system and installation.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amber/Booth Company, Inc.
   2. Vibro-acoustics.
   3. ISAT
   4. Mason Industries.
   5. Caddy

6. Prior approved equal.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
   1. Resilient Material: Oil- and water-resistant neoprene or rubber.

C. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
   1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
   3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.02 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amber/Booth Company, Inc.
   2. Hilti, Inc.
   3. ISAT
   4. Kinetics Noise Control.
   5. Mason Industries.
   6. Vibro-acoustics.
   7. Gripple.
   8. Unistrut; Tyco International, Ltd.
   9. Prior approved equal.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
   1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
   1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.

2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Restraint Cables: -steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.

G. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

J. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

K. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.03 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic- and wind-control devices to indicate capacity range.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.03 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:
   1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
   2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
   3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. Piping Restraints:
   1. Comply with requirements in MSS SP-127.
   2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
   3. Brace a change of direction longer than 12 feet.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

H. Drilled-in Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
   5. Set anchors to manufacturer's recommended torque, using a torque wrench.
   6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Leave a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:
   1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.06 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust air-spring leveling mechanism.

D. Adjust active height of spring isolators.

E. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION

SECTION 22 05 53

IDENTIFICATION FOR MECHANICAL AND PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:
   1. Equipment nameplates.
   2. Equipment signs.
   3. Access panel and door markers.
   4. Pipe markers.
   5. Warning tags.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.04 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.05 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.01 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
   1. Data:
      a. Manufacturer, product name, model number, and serial number.
      b. Capacity, operating and power characteristics, and essential data.
      c. Labels of tested compliances.
   2. Location: Accessible and visible.
   3. Fasteners: As required to mount on equipment.

B. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
   1. Data: Instructions for operation of equipment and for safety procedures.
   2. Engraving: Manufacturer's standard letter style, 1/4” or larger with terms to match equipment identification.
   3. Thickness: 1/8 inch, unless otherwise indicated.
   4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

C. Access Panel and Door Markers: 1/16” thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8” center hole for attachment.
   1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.02 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Bradley.
      b. Kolbi.
      c. Prior approved.
   2. Colors: Comply with ASME A13.1, unless otherwise indicated.
   3. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
   4. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
   5. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
   6. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

PART 1 - EXECUTION

2.03 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 22 and 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

2.04 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
   1. Fuel-burning units, including boilers, furnaces, heaters, etc.
   2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
   3. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
   4. Fans, blowers, primary balancing dampers, and mixing boxes.
   5. Packaged HVAC central-station and zone-type units.

B. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.
   1. Identify mechanical equipment with black equipment markers with white lettering.
   2. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
   4. Include signs for the following general categories of equipment:
      a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
      b. Fuel-burning units, including boilers, furnaces, heaters, etc.
      c. Pumps, compressors, chillers, condensers, and similar motor-driven units.
      d. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
      e. Fans, blowers, primary balancing dampers, and mixing boxes.
      f. Packaged HVAC central-station and zone-type units.
      g. Tanks and pressure vessels.
      h. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

C. Install access panel markers with screws on equipment access panels.

2.05 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

C. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

2.06 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

2.07 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION

SECTION 22 07 00

PLUMBING INSULATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Insulation Materials:
      a. Mineral fiber.
   2. Insulating cements.
   3. Adhesives.
   4. Lagging adhesives.
   5. Factory-applied jackets.
   6. Field-applied jackets.
   7. Tapes.
   8. Securements.
   9. Corner angles.

B. Related Sections:
   1. Division 23 Section "Metal Ducts" for duct liners.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Qualification Data: For qualified Installer.

C. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

D. Field quality-control reports.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.06 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 and 23 Section "Hangers and Supports."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.07 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Fibrex Insulations Inc.; Coreplus 1200.
      b. Johns Manville; Micro-Lok.
      c. Knauf Insulation; 1000 Pipe Insulation.
      d. Manson Insulation Inc.; Alley-K.
      e. Owens Corning; Fiberglas Pipe Insulation.
      f. Prior approved equal.
   2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A.

2.02 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Insulco, Division of MFS, Inc.; Triple I.
      b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.
      c. Prior approved equal.

2.03 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-127.
      b. Foster Products Corporation, H. B. Fuller Company; 85-60/ 85-70.
      c. Marathon Industries, Inc.; 225.
      d. Mon-Eco Industries, Inc.; 22-25.
      e. Prior approved equal.

2.04 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of H.B. Fuller; CR 50 AHV2.
      b. Foster Products Corporation, H. B. Fuller Company; 30-36.
      c. Vimasco Corporation; 713 and 714.
      d. Prior approved equal.
   2. Service Temperature Range: Minus 50 to plus 180 deg F.
   3. Color: White.

2.05 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.06 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
      b. Compac Corp.; 104 and 105.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
      e. Prior approved equal.
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      b. Compac Corp.; 110 and 111.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
      d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
      e. Prior approved equal.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
   8. Adhesion: 64 ounces force/inch in width.
   9. Elongation: 500 percent.

10. Tensile Strength: 18 lbf/inch in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
      b. Compac Corp.; 120.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
      d. Venture Tape; 3520 CW.
      e. Prior approved equal.
   2. Width: 2 inches.
   3. Thickness: 3.7 mils.
   4. Adhesion: 100 ounces force/inch in width.
   5. Elongation: 5 percent.
   6. Tensile Strength: 34 lbf/inch in width.

2.07 SECUREMENTS

A. Bands:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products; Bands.
      b. PABCO Metals Corporation; Bands.
      c. RPR Products, Inc.; Bands.
      d. Prior approved equal.
   2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide.
   3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide.
   4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

2.08 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Manholes.
   5. Handholes.
   6. Cleanouts.

3.04 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
   6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
   7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
   8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
   9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
   1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
   2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
   3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
   4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
   5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.05 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.06 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.07 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
   2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
   3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.08 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
   4. Vertical roof drain piping.

C. Piping System insulation:
   1. Domestic Cold Water Piping -Mineral Fiber, ½"
   2. Domestic Hot Water Piping -Mineral Fiber, per chart
   3. Horizontal Roof Drain Piping - Mineral Fiber, 1/2".

3.09 INDOOR PIPING INSULATION SCHEDULE

A. Minimum Pipe Insulation Thickness per 2021 IECC

Fluid Operating Temperature Range and usage (F°)	Insulation Conductivity		Nominal Pipe or Tube Size (inches)				
	Conductivity Btu-in./(h-ft²-F°)	Mean Rating Temp. F°	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
Heating Systems (Steam, Steam Condensate, and Hot Water)							
>350	0.32-0.34	250	4.5	5.0	5.0	5.0	5.0
251-350	0.29-0.32	200	3.0	4.0	4.5	4.5	4.5
201-250	0.27-0.30	150	2.5	2.5	2.5	3.0	3.0
141-200	0.25-0.29	125	1.5	1.5	2.0	2.0	2.0
105-140	0.21-0.28	100	1.0	1.0	1.5	1.5	1.5
Cooling Systems (Chilled Water, Brine, and Refrigerant)							
40-60	0.21-0.27	75	0.5	0.5	1.0	1.0	1.0
<40	0.20-0.26	50	0.5	1.0	1.0	1.0	1.5

3.10 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:
   1. PVC: 20 mils thick.

D. Minimum Pipe Insulation Thickness from ANSI/ASHRAE/IESNA Standard 90.1-2016, with modifications per 2018 IECC

3.11 OUTDOOR, FIELD APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Exterior piping, Exposed:
   1. Aluminum jacket.

END OF SECTION

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
   2. Flexible connectors.
   3. Escutcheons.
   4. Sleeves and sleeve seals.
   5. Wall penetration systems.

1.03 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions determined according to 2012 IBC.

1.04 SUBMITTALS

A. Product Data: For the following products:
   1. Specialty valves.
   2. Transition fittings.
   3. Dielectric fittings.
   4. Escutcheons.
   5. Sleeves and sleeve seals.

B. Water Samples: Specified in "Cleaning" Article.

C. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 61 for potable domestic water piping and components.

1.06 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of water service.
   2. Do not proceed with interruption of water service without Owner's written permission.

1.07 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
   1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
   2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
   3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
   4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.03 PIPING JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.04 ESCUTCHEONS

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.

C. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.

D. One Piece, Stamped Steel: Chrome-plated finish with setscrew or spring clips.

E. Split Casting, Cast Brass: Polished, chrome-plated finish with concealed hinge and setscrew.

F. Split Plate, Stamped Steel: Chrome-plated finish with concealed hinge, setscrew or spring clips.

G. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

H. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.05 SLEEVES

A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

C. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

D. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.

E. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

F. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.

G. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with setscrews.

2.06 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Inc.
   2. Calpico, Inc.
   3. Metraflex, Inc.
   4. Pipeline Seal and Insulator, Inc.
   5. Prior approved equal.

B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Carbon steel.
   3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.07 GROUT

A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 EARTHWORK

A. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105.

E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 and 23 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.

H. Install domestic water piping level without pitch and plumb.

I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

J. Install seismic restraints on piping. Comply with requirements in Division 22 and 23 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

K. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

L. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

M. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

N. Install piping adjacent to equipment and specialties to allow service and maintenance.

O. Install piping to permit valve servicing.

P. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

Q. Install piping free of sags and bends.

R. Install fittings for changes in direction and branch connections.

S. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

T. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.

U. Install thermometers on outlet piping from each water heater. Comply with requirements in Division 22 and 23 Section "Meters and Gages for Plumbing Piping" for thermometers.

3.03 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.04 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 and 23 Section "General-Duty Valves for Plumbing Piping" for valve installations.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
   1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
   2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller and butterfly valves for piping NPS 2-1/2 and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.

3.05 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:
   1. NPS 1-1/2 and Smaller: Fitting-type coupling.
   2. NPS 2 and Larger: Sleeve-type coupling.

3.06 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 and 23 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 22 and 23 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.

b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Feet If Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.07 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
   2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 15 plumbing fixture Sections for connection sizes.
   4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.08 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors.

B. Escutcheons for New Piping:
   1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
   2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
   3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
   4. Bare Piping in Unfinished Service Spaces: One piece, stamped steel with set screw or spring clips.
   5. Bare Piping in Equipment Rooms: One piece, stamped steel with set screw or spring clips.
   6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

C. Escutcheons for Existing Piping:
   1. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
   2. Insulated Piping: Split plate, stamped steel with concealed or exposed-rivet hinge and spring clips.
   3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
   4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
   5. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel with exposed-rivet hinge and set screw or spring clips.
   6. Bare Piping in Equipment Rooms: Split plate, stamped steel with set screw or spring clips.
   7. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

3.09 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint.

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint.

H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals specified in this Section.

I. Seal space outside of sleeves in concrete slabs and walls with grout.

J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

K. Install sleeve materials according to the following applications:
   1. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe.
   2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe.
      a. Extend sleeves 2 inches above finished floor level.
      b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
   3. Sleeves for Piping Passing through Gypsum-Board Partitions:
      a. PVC pipe sleeves for pipes smaller than NPS 6.
      b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.
      c. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
   4. Sleeves for Piping Passing through Concrete Roof Slabs: Steel pipe Insert type.
   5. Sleeves for Piping Passing through Exterior Concrete Walls:
      a. Steel pipe sleeves for pipes smaller than NPS 6.
      b. Cast-iron wall pipe sleeves for pipes NPS 6 and larger.
      c. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
      d. Do not use sleeves when wall penetration systems are used.
   6. Sleeves for Piping Passing through Interior Concrete Walls:
      a. Steel pipe sleeves for pipes smaller than NPS 6.
      b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestop materials and installations.

3.10 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.11 WALL PENETRATION SYSTEM INSTALLATION

A. Install wall penetration systems in new, exterior concrete walls.

B. Assemble wall penetration system components with sleeve pipe. Install so that end of sleeve pipe and face of housing are flush with wall. Adjust locking devices to secure sleeve pipe in housing.

3.12 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 and 23 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

B. Label pressure piping with system operating pressure.

3.13 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:
   1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
      b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
   3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:
   1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
   3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   4. Cap and subject piping to static water pressure of 100 psig, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
   6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.14 ADJUSTING

A. Perform the following adjustments before operation:
   1. Close drain valves, hydrants, and hose bibbs.
   2. Open shutoff valves to fully open position.
   3. Open throttling valves to proper setting.
   4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
      a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
      b. Adjust calibrated balancing valves to flows indicated.
   5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
   6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
   7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
   8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.15 CLEANING

A. Clean and disinfect potable and non-potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:
        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Clean non-potable domestic water piping as follows:
    1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
    2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
        a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
        b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.16 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Aboveground domestic water piping shall be the following:
    1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.

3.17 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
    1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.

2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION

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SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following domestic water piping specialties:
   1. Vacuum breakers.
   2. Strainers.
   3. Hose bibbs.
   4. Drain valves.
   5. Circuit Setters

1.03 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For domestic water piping specialties to include in operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NSF Compliance:
   1. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 PRODUCTS

2.01 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ames Co.
      b. Cash Acme.
      c. Conbraco Industries, Inc.
      d. FEBCO; SPX Valves & Controls.
      e. Rain Bird Corporation.
      f. Toro Company (The); Irrigation Div.
      g. Watts Industries, Inc.; Water Products Div.
      h. Zurn Plumbing Products Group; Wilkins Div.
      i. Prior approved equal.
   2. Standard: ASSE 1001.
   3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
   4. Body: Bronze.
   5. Inlet and Outlet Connections: Threaded.
   6. Finish: Rough bronze.

B. Hose-Connection Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Arrowhead Brass Products, Inc.
      b. Cash Acme.
      c. Conbraco Industries, Inc.
      d. Legend Valve.
      e. MIFAB, Inc.
      f. Prier Products, Inc.
      g. Watts Industries, Inc.; Water Products Div.
      h. Woodford Manufacturing Company.
      i. Zurn Plumbing Products Group; Light Commercial Operation.
      j. Zurn Plumbing Products Group; Wilkins Div.
      k. Prior approved equal.
   2. Standard: ASSE 1011.
   3. Body: Bronze, nonremovable, with manual drain.
   4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
   5. Finish: Chrome or nickel plated.

2.02 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:
   1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
   2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
   3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
   4. Screen: Stainless steel with round perforations, unless otherwise indicated.
   5. Drain: Factory-installed, hose-end drain valve.

2.03 HOSE BIBBS

A. Hose Bibbs:
   1. Standard: ASME A112.18.1 for sediment faucets.
   2. Body Material: Bronze.
   3. Seat: Bronze, replaceable.
   4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
   5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
   6. Pressure Rating: 125 psig.
   7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
   8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
   9. Finish for Service Areas: Chrome or nickel plated.
   10. Finish for Finished Rooms: Chrome or nickel plated.
   11. Operation for Equipment Rooms: Wheel handle or operating key.
   12. Operation for Service Areas: Wheel handle.
   13. Operation for Finished Rooms: Operating key.
   14. Include operating key with each operating-key hose bibb.
   15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.04 DRAIN VALVES

A. Ball-Valve-Type, Threaded-End Drain Valves:
   1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
   2. Pressure Rating: 400-psig minimum CWP.
   3. Size: 1.5”
   4. Body: Copper alloy.
   5. Ball: Chrome-plated brass.
   6. Seats and Seals: Replaceable.
   7. Handle: Vinyl-covered steel.
   8. Inlet: Threaded or solder joint.
   9. Outlet: Threaded, short nipple cap with brass chain.

2.05 CIRCUIT SETTERS

A. Domestic Hot Water Recirc circuit setters shall be thermostatic balance valve. Shall be one of the following manufacturers.
   1. Bell and Gossett Temp Setter or equal by:
   2. Caleffi
   3. Prior approved equal.

2.06 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ames Co.
      b. Conbraco Industries, Inc.
      c. FEBCO; SPX Valves & Controls.
      d. Flomatic Corporation.
      e. Watts Industries, Inc.; Water Products Div.
      f. Zurn Plumbing Products Group; Wilkins Div.
      g. Prior approved equal.
   2. Standard: ASSE 1013.
   3. Operation: Continuous-pressure applications.
   4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
   5. Body: Bronze for NPS 2 and smaller; steel with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
   6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
   7. Accessories:
      a. Valves: Ball type with threaded ends on inlet and outlet ofNPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
      b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Hose-Connection Backflow Preventers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.
      b. Watts Industries, Inc.; Water Products Div.
      c. Woodford Manufacturing Company.
      d. Prior approved equal.
   2. Standard: ASSE 1052.
   3. Operation: Up to 10-foot head of water back pressure.
   4. Inlet Size: NPS 1/2 or NPS 3/4.
   5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
   6. Capacity: At least 3-gpm flow.

2.07 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cash Acme.
      b. Conbraco Industries, Inc.
      c. Honeywell Water Controls.
      d. Watts Industries, Inc.; Water Products Div.
      e. Zurn Plumbing Products Group; Wilkins Div.
      f. Prior approved equal.
   2. Standard: ASSE 1003.
   3. Pressure Rating: Initial working pressure of 150 psig.
   4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
   5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.08 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Primary, Electronic, Water Mixing Valves:
   1. Approved Manufacturers:
      a. Acorn Basyc
      b. Armstrong Brain
      c. Caleffi
      d. Watts
      e. Prior approved equal
   2. Standard: ASSE 1017.
   3. Pressure Rating: 125 psig minimum unless otherwise indicated.
   4. Type: Exposed, electronically controlled, water mixing valve.
   5. Material: Bronze body with corrosion-resistant interior components.
   6. Connections: Threaded or solder joint inlets and outlet.
   7. Accessories: Manual temperature override control, check stops on hot- and cold-water supplies, and automatic hot- and cold-water shutoff upon inlet supply failure.
   8. Tempered-Water Setting: 120 .
   9. Pressure Drop at Design Flow Rate: 10 .
   10. Valve Finish: Bronze.
   11. Digital temperature control and monitoring module.
      a. Controls temperature within plus or minus 2 deg F.
      b. User programmable at module or through BAS.
      c. ASHRAE 188 compliance.
      d. Local and remote monitoring.
      e. BACNet protocol language(s).

f. 115 V ac, 60 Hz.
g. Battery backup.

B. Individual-Fixture, Water Tempering Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Sloan.
b. Watts.
c. Prior approved equal.
2. Standard: ASSE 1016, thermostatically controlled water tempering valve.
3. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.
8. Tempered-Water Setting: 110E F.

2.09 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. MIFAB, Inc.
b. Josam Company.
c. Prier Products, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Tyler Pipe; Wade Div.
f. Watts Drainage Products Inc.
g. Woodford Manufacturing Company.
h. Zurn Plumbing Products Group; Light Commercial Operation.
i. Zurn Plumbing Products Group; Specification Drainage Operation.
j. Or equal by.

B. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
1. Pressure Rating: 125 psig (860 kPa).
2. Operation: Loose key.
3. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
4. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).
5. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
6. Box: Deep, flush mounting with cover.
7. Box and Cover Finish: Chrome plated.

8. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
9. Nozzle and Wall-Plate Finish: Polished nickel bronze.
10. Operating Keys(s): Two with each wall hydrant.

C. Vacuum Breaker Wall Hydrants:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Arrowhead Brass Products, Inc.
b. Mansfield Plumbing Products LLC.
c. McDonald, A. Y. Mfg. Co.
d. Prier Products, Inc.
e. Smith, Jay. R. Mfg. Co.; Division of Smith Industries, Inc.
f. Watts Industries, Inc.; Water Products Div.
g. Woodford Manufacturing Company.
h. Zurn Plumbing Products Group; Light Commercial Operation.
i. Or equal by.
1) Standard: ASSE 1019, Type A or Type B.
2) Type: Freeze-resistant, automatic draining with integral air-inlet valve.
3) Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
4) Pressure Rating: 125 psig (860 kPa).
5) Operation: Loose key.
6) Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
7) Inlet: NPS 1/2 or NPS 3/4 (DN 15 or DN 20).
8) Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.10 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AMTROL, Inc.
b. Josam Company.
c. MIFAB, Inc.
d. PPP Inc.
e. Sioux Chief Manufacturing Company, Inc.
f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
g. Tyler Pipe; Wade Div.
h. Watts Drainage Products Inc.
i. Zurn Plumbing Products Group; Specification Drainage Operation.
j. Or equal by.
2. Standard: ASSE 1010 or PDI-WH 201.

3. Type: Metal bellows Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.11 AIR VENTS

A. Bolted-Construction Automatic Air Vents:
   1. Body: Bronze.
   2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
   3. Float: Replaceable, corrosion-resistant metal.
   4. Mechanism and Seat: Stainless steel.
   5. Size: NPS 1/2 minimum inlet.
   6. Inlet and Vent Outlet End Connections: Threaded.

2.12 CIRCUIT SETTERS

A. Domestic Hot Water Recirc circuit setters shall be thermostatic balance valve. Shall be one of the following manufacturers.
   1. Bell and Gossett Temp Setter or equal by:
   2. Caleffi
   3. Prior approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to Division 22 and 23 Section "Common work results" for piping joining materials, joint construction, and basic installation requirements.

B. Revise remaining paragraphs and subparagraphs in this Article to include specific installation requirements.

C. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping and specialties

3.03 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:
   1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.04 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION

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SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Pipe, tube, and fittings.
   2. Specialty pipe fittings.

B. Related Sections:
   1. Division 2 Section "Sanitary Sewerage" for sanitary sewerage piping and structures outside the building.

1.03 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated.\

B. Shop Drawings: For sovent drainage system. Include plans, elevations, sections, and details.

C. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

1.06 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Owner no fewer than 72 hours in advance of proposed interruption of sanitary waste service.
   2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service and Extra Heavy class(es).

B. Gaskets: ASTM C 564, rubber.

2.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      b. Fernco Inc.
      c. MIFAB, Inc.
      d. Tyler Pipe.
      e. Ideal
      f. Prior approved equal.
   2. Standards: ASTM C 1277 and CISPI 310.
   3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      b. MIFAB, Inc.
      c. Tyler Pipe.

d. Ideal
e. Prior approved equal.

2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.04 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.
1. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Solvent Cement: ASTM D 2564.
1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.05 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Dallas Specialty & Mfg. Co.
2) Fernco Inc.
3) Mission Rubber Company; a division of MCP Industries, Inc.
4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
5) Prior approved equal.
b. Standard: ASTM C 1173.
c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. Sleeve Materials:
1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        1) Cascade Waterworks Mfg. Co.
        2) Mission Rubber Company; a division of MCP Industries, Inc.
        3) Prior approved equal.
    b. Standard: ASTM C 1460.
    c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
5. Pressure Transition Couplings:
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
        1) Cascade Waterworks Mfg. Co.
        2) Dresser, Inc.
        3) EBAA Iron, Inc.
        4) JCM Industries, Inc.
        5) Romac Industries, Inc.
        6) Smith-Blair, Inc; a Sensus company.
        7) The Ford Meter Box Company, Inc.
        8) Viking Johnson.
        9) Prior approved equal.

PART 3 EXECUTION

3.01 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 2 Section "Earthwork."

3.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 and 23 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
   1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
   3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
   1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

O. Install aboveground ABS piping according to ASTM D 2661.

P. Install aboveground PVC piping according to ASTM D 2665.

Q. Install underground ABS and PVC piping according to ASTM D 2321.

R. Install engineered soil and waste drainage and vent piping systems as follows:
   1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
   2. Sovent Drainage System: Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.

3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

S. Plumbing Specialties:
   1. Install backwater valves in sanitary waste gravity-flow piping. Comply with requirements for backwater valves specified in Division 22 and 23 Section "Sanitary Waste Piping Specialties."
   2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 and 23 Section "Sanitary Waste Piping Specialties."
   3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 and 23 Section "Sanitary Waste Piping Specialties."

T. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 and 23 Section "Sleeves and Sleeve Seals for Plumbing Piping."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 and 23 Section "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 and 23 Section "Escutcheons for Plumbing Piping."

3.03 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
   3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.04 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in OD's.
   2. In Drainage Piping: Shielded, nonpressure transition couplings.
   3. In Aboveground Force Main Piping: Fitting-type transition couplings.
   4. In Underground Force Main Piping:
      a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
      b. NPS 2and Larger: Pressure transition couplings.

B. Dielectric Fittings:
   1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

3.05 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 and 23 Section "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:
   1. Install shutoff valve on each sewage pump discharge.
   2. Install gate or full-port ball valve for piping NPS 2 and smaller.
   3. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.
   1. Horizontal Piping: Horizontal backwater valves.
   2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
   3. Install backwater valves in accessible locations.
   4. Comply with requirements for backwater valve specified in Division 22 and 23 Section "Sanitary Waste Piping Specialties."

3.06 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Division 22 and 23 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 and 23 Section "Hangers and Supports for Plumbing Piping and Equipment."
   1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
   2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
   3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
   4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
   5. Vertical Piping: MSS Type 8 or Type 42, clamps.
   6. Install individual, straight, horizontal piping runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
   7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches of each fitting[,valve,] and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
   5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
   6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.07 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:
   1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
   2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
   3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
   4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
   5. Comply with requirements for backwater valves cleanouts and drains specified in Division 22 and 23 Section "Sanitary Waste Piping Specialties."
   6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.08 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 and 23 Section "Identification for Plumbing Piping and Equipment."

3.09 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
   4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
   5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   6. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste and vent piping shall be any of the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

C. Underground, soil, waste, and vent piping shall be any of the following:
   1. Extra Heavy class, cast-iron soil piping; calking materials; and calked joints.

2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
3. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

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SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:
   1. Cleanouts.
   2. Floor drains.
   3. Air-admittance valves.
   4. Trap Guards.
   5. Roof flashing assemblies.
   6. Miscellaneous sanitary drainage piping specialties.
   7. Flashing materials.

1.03 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene plastic.

D. PE: Polyethylene plastic.

E. PVC: Polyvinyl chloride plastic.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer, rated capacities, operating characteristics, and accessories for the following:
   1. Cleanouts.
   2. Floor drains.
   3. Air admittance valves.

1.05 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.06 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 PRODUCTS

2.01 CLEANOUTS

A. Exposed Metal Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company; Josam Div.
      b. MIFAB, Inc.
      c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      d. Tyler Pipe; Wade Div.
      e. Watts Drainage Products Inc.
      f. Zurn Plumbing Products Group; Specification Drainage Operation.
      g. Prior approved equal.
   2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
   3. Size: Same as connected drainage piping
   4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
   5. Closure: Countersunk or raised-head, cast-iron plug.
   6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.02 FLOOR DRAINS

A. Cast-Iron Floor Drains:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Commercial Enameling Co.
      b. Josam Company; Josam Div.
      c. MIFAB, Inc.
      d. Prier Products, Inc.
      e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      f. Tyler Pipe; Wade Div.
      g. Watts Drainage Products Inc.
      h. Zurn Plumbing Products Group; Light Commercial Operation.
      i. Zurn Plumbing Products Group; Specification Drainage Operation.
      j. Prior approved equal.
   2. Standard: ASME A112.6.3.
   3. Pattern: Floor drain.

4. Body Material: Gray iron.
5. Clamping Device: Required.
6. Outlet: Bottom.
7. Top or Strainer Material: Chrome plate
8. Top or Strainer Material: Stainless steel for shower drains
9. Top Shape: Round.
10. Top Loading Classification: Medium Duty.
11. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
12. Trap Pattern: Deep-seal P-trap.
13. Trap Features: Trap-seal primer valve drain connection.

2.03 AIR-ADMITTANCE VALVES

A. Wall Box:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Durgo, Inc.
      b. Oatey.
      c. RectorSeal.
      d. Studor, Inc.
      e. Prior approved equal.
   2. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
   3. Size: About 9 inches wide by 8 inches high by 4 inches deep.

2.04 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Acorn Engineering Company; Elmdor/Stoneman Div.
      b. Thaler Metal Industries Ltd.
      c. Prior approved equal.

B. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch- thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
   1. Open-Top Vent Cap: Without cap.
   2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
   3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.05 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:
   1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
   2. Size: Same as connected waste piping.
      a. NPS 2: 4-inch- minimum water seal.
      b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

B. Floor-Drain, Trap-Seal Primer Fittings:
   1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
   2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

C. Trap Guard
   1. Description: Trap guard shall have flexible elastomeric material open on top, with curl closure on bottom as needed to allow water to flow, but not allow sewer gases to escape.
   2. Trap guards by Proset or prior approved equal.

2.06 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
   1. General Applications: 12 oz./sq. ft. thickness.
   2. Vent Pipe Flashing: 8 oz./sq. ft. thickness.

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to Division 22 and 23 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
      a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
      b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
      c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
   3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
   4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

G. Install air-admittance-valve wall boxes recessed in wall where indicated on drawings.

H. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

I. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

J. Install deep-seal traps on all floor drains.

K. Install trap guards at floor drains that require trap-seal.
   1. Size: Same as floor drain inlet.

L. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

M. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

N. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.03 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
   2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 7 Section "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.04 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.05 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

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SECTION 22 33 00

ELECTRIC WATER HEATERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following electric water heaters:
   1. Flow-control, instantaneous electric water heaters.
   2. Light-commercial electric water heaters.
   3. Compression tanks.
   4. Water heater accessories.

1.03 SUBMITTALS

A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Product Certificates: For each type of commercial and instantaneous electric water heater, signed by product manufacturer.

D. Manufacturer Seismic Qualification Certification: Submit certification that commercial water heaters, accessories, and components will withstand seismic forces defined in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
      b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For electric water heaters to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of electric water heaters through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of electric water heaters and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

1.05 COORDINATION

A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including storage tank and supports.
      b. Faulty operation of controls.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use.
   2. Warranty Period(s): From date of Substantial Completion:
      a. Instantaneous Electric Water Heaters: One year.
      b. Light-Commercial Electric Water Heaters:
         1) Storage Tank: Five years.
         2) Controls and Other Components: Two years.
      c. Compression Tanks: One year.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 INSTANTANEOUS ELECTRIC WATER HEATERS

A. Flow-Control, Instantaneous Electric Water Heaters: Comply with UL 499 for tankless electric (water heater) heating appliance.
   1. Manufacturers:
      a. Chronomite Laboratories, Inc.
      b. Eemax, Inc.
      c. Hot Aqua, Inc.
      d. Intellihot
      e. HTP
      f. Bock
      g. Prior approved equal.
   2. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
      a. Connections: ASME B1.20.1 pipe thread.
      b. Pressure Rating: 150 psig.
      c. Heating Element: Resistance heating system.
      d. Temperature Control: Flow-control fitting.
      e. Safety Control: High-temperature-limit cutoff device or system.
      f. Jacket: Aluminum or steel with enameled finish or plastic.
   3. Support: Bracket for wall mounting.
   4. Capacity and Characteristics:
      a. Temperature Control: Flow-control fitting.
      b. See drawings for capacity, electrical service, etc.

2.03 LIGHT-COMMERCIAL ELECTRIC WATER HEATERS

A. Description: Comply with UL 174 for household, storage electric water heaters.
   1. Manufacturers:
      a. American Water Heater Company.
      b. Bradford White Corporation.
      c. Electric Heater Company (The); Hubbell Heaters Division.
      d. GSW Water Heating Company.
      e. Heat Transfer Products, Inc.
      f. Lochinvar Corporation.
      g. Rheem Water Heater Div.; Rheem Manufacturing Company.

h. Ruud Water Heater Div.; Rheem Manufacturing Company.
i. Smith, A. O. Water Products Company.
j. State Industries, Inc.
k. Prior approved equal.

2. Storage-Tank Construction: Steel, vertical arrangement.
   a. Tappings: ASME B1.20.1 pipe thread.
   b. Pressure Rating: 150 psig.
   c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
3. Factory-Installed Storage-Tank Appurtenances:
   a. Anode Rod: Replaceable magnesium.
   b. Dip Tube: Provide unless cold-water inlet is near bottom of tank.
   c. Drain Valve: ASSE 1005.
   d. Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2.
   e. Jacket: Steel with enameled finish.
   f. Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
   g. Heating Elements: Two; electric, screw-in immersion type; wired for simultaneous operation, unless otherwise indicated.
   h. Temperature Control: Adjustable thermostat for each element.
   i. Safety Control: High-temperature-limit cutoff device or system.
   j. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
4. Special Requirements: NSF 5 construction with legs for off-floor installation.
5. Capacity and Characteristics:
   a. See drawings for size, capacity, electrical characteristics, etc.

2.04 COMPRESSION TANKS

A. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
   1. Manufacturers:
      a. AMTROL Inc.
      b. Armstrong Pumps, Inc.
      c. Flexcon Industries.
      d. Honeywell Sparco.
      e. Myers, F. E.; Pentair Pump Group (The).
      f. Smith, A. O.; Aqua-Air Div.
      g. State Industries, Inc.
      h. Taco, Inc.

i. Watts Regulator Co.
j. Wessels Co.
k. Prior approved equal.

2. Construction:
   a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
   b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Air-Charging Valve: Factory installed.
3. Capacity and Characteristics: See drawings.

2.05 WATER HEATER ACCESSORIES

A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

B. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than water heater working-pressure rating.

C. Water Heater Stand and Drain-Pan Units: High-density-polyethylene-plastic, 18-inch-high, enclosed-base stand complying with IAPMO PS 103 and IAS No. 2. Include integral or separate drain pan with raised edge and NPS 1 drain outlet with ASME B1.20.1 pipe thread.

D. Water Heater Stands: Water heater manufacturer's factory-fabricated steel stand for floor mounting and capable of supporting water heater and water. Include dimension that will support bottom of water heater a minimum of 18 inches above the floor.

E. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.

F. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than NPS 3/4.

G. Piping Manifold Kits: Water heater manufacturer's factory-fabricated inlet and outlet piping arrangement for multiple-unit installation. Include piping and valves for field assembly that are capable of isolating each water heater and of providing balanced flow through each water heater.

H. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

I. Water Regulators: ASSE 1003, water-pressure reducing valve. Set at 25-psig- maximum outlet pressure, unless otherwise indicated.

J. Shock Absorbers: ASSE 1010 or PDI WH 201, Size A water hammer arrester.

PART 3 EXECUTION

3.01 WATER HEATER INSTALLATION

A. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

B. Install seismic restraints for light-commercial and commercial water heaters. Anchor to substrate.

C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 and 23 Section "Plumbing Specialties" for hose-end drain valves.

F. Install thermometer on outlet piping of water heaters. Refer to Division 22 and 23 Section "Meters and Gages" for thermometers.

G. Install thermometers on inlet and outlet piping of household, collector-to-tank, solar-electric water heaters. Refer to Division 22 and 23 Section "Meters and Gages" for thermometers.

H. Install pressure gage(s) on inlet and outlet of commercial electric water- heater piping. Refer to Division 22 and 23 Section "Meters and Gages" for pressure gages.

I. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each water heater. Include shutoff valve, thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet. Refer to Division 22 and 23 Section "Valves" for general-duty valves and to Division 22 and 23 Section "Meters and Gages" for thermometers.

J. Install water regulator, with integral bypass relief valve, in booster-heater inlet piping and water hammer arrester in booster-heater outlet piping.

K. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.

L. Fill water heaters with water.

M. Charge compression tanks with air.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.03 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial and instantaneous electric water heaters. Refer to Division 1 Section "Closeout Procedures Demonstration and Training."

END OF SECTION

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SECTION 22 40 00

PLUMBING FIXTURES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following conventional plumbing fixtures and related components:
   1. Lavatories.
   2. Lavatory Faucets.
   3. Water closets.
   4. Toilet seats.
   5. Flushometers - Water Closets.
   6. Urinals.
   7. Flushometers - Urinals.
   8. Fixture supports.
   9. Protective shielding guards.
   10. Commercial sinks.
   11. Sink Faucets.
   12. Service sinks.

B. Related Sections include the following:
   1. Division 22 Section "Plumbing Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.

1.03 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

F. FRP: Fiberglass-reinforced plastic.

G. PMMA: Polymethyl methacrylate (acrylic) plastic.

H. PVC: Polyvinyl chloride plastic.

I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.04 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. Operation and Maintenance Data: For plumbing fixtures to include in operation, and maintenance manuals.

C. Warranty: Special warranty specified in this Section.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
   1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
   1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
   2. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
   3. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
   4. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.

5. Vitreous-China Fixtures: ASME A112.19.2M.
6. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
7. Water-Closet, Flushometer Tank Trim: ASSE 1037.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
   1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
   2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
   3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
   4. Faucets: ASME A112.18.1.
   5. Hose-Connection Vacuum Breakers: ASSE 1011.
   6. Hose-Coupling Threads: ASME B1.20.7.
   7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
   8. NSF Potable-Water Materials: NSF 61.
   9. Pipe Threads: ASME B1.20.1.
   10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
   11. Supply Fittings: ASME A112.18.1.
   12. Brass Waste Fittings: ASME A112.18.2.

I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
   1. Atmospheric Vacuum Breakers: ASSE 1001.
   2. Brass and Copper Supplies: ASME A112.18.1.
   3. Manual-Operation Flushometers: ASSE 1037.
   4. Plastic Tubular Fittings: ASTM F 409.
   5. Brass Waste Fittings: ASME A112.18.2.
   6. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   1. Disposers: ASSE 1008 and UL 430.
   2. Flexible Water Connectors: ASME A112.18.6.
   3. Floor Drains: ASME A112.6.3.
   4. Grab Bars: ASTM F 446.
   5. Hose-Coupling Threads: ASME B1.20.7.
   6. Hot-Water Dispensers: ASSE 1023 and UL 499.
   7. Off-Floor Fixture Supports: ASME A112.6.1M.
   8. Pipe Threads: ASME B1.20.1.
   9. Plastic Toilet Seats: ANSI Z124.5.
   10. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.06 WARRANTY

A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures of unit shell.
      b. Faulty operation of controls, blowers, pumps, heaters, and timers.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use.
   2. Warranty Period: One year from date of Substantial Completion.

1.07 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
   2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
   3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 2 of each type.
   4. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.

PART 2 PRODUCTS

2.01 LAVATORIES

A. Lavatories:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Inc.
      b. Commercial Enameling Company.
      c. Eljer.
      d. Kohler Co.
      e. Crane.
      f. Sloan
      g. Zurn.
   2. Description: Accessible, wall-mounting, vitreous-china fixture.
      a. Type: With back.
      b. Size: 20 by 18 inches rectangular.
      c. Faucet Hole Punching: Three holes, 4-inch centers.
      d. Color: White.

e. Supplies: NPS 3/8 chrome-plated copper with stops.
f. Drain: Grid with offset waste.
g. Location: Near back of bowl.

B. Lavatories, Counter Mounted:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Commercial Enameling Company.
b. Eljer.
c. Kohler Co.
d. American Standard.
e. Crane.
f. Sloan
g. Zurn.
h. Prior approved equal.
2. Description: Accessible Counter-mounting, vitreous-china fixture.
a. Type: Self-rimming.
b. Oval Lavatory Size: 20 by 17 inches.
c. Faucet Hole Punching: Three holes, 4-inch centers.
d. Color: White.
e. Supplies: NPS 3/8 chrome-plated copper with stops.
f. Drain: Grid with offset waste.
1) Location: Near back of bowl.

C. Mixing valve:
1. Valve shall be thermostatic and pressure mixing valve with maximum 5 degree approach temperature.
2. Approved Manufacturers -
a. Powers hydroguard TP or equal by
b. Sloan
c. Prior approved equal

2.02 LAVATORY FAUCETS

A. Lavatory Faucets:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Standard Companies, Inc.
b. Bradley Corporation.
c. Chicago Faucets.
d. Delta Faucet Company.
e. Eljer.
f. Elkay Manufacturing Co.
g. Fisher Manufacturing Co.

h. Just Manufacturing Company.
i. Kohler Co.
j. Moen, Inc.
k. Royal Brass Mfg. Co.
l. Sayco; a Briggs Plumbing Products, Inc. Company.
m. Speakman Company.
n. Sloan
o. T & S Brass and Bronze Works, Inc.
p. Zurn Plumbing Products Group; Commercial Brass Operation.
q. Prior approved equal.

2. Description: Sensor. Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
   a. Body Material: Commercial, solid brass.
   b. Finish: Polished chrome plate.
   c. Maximum Flow Rate: 0.5 gpm.
   d. Centers: 4 inches.
   e. Mounting: Deck, concealed.
   f. Spout: Rigid type.
   g. Spout Outlet: Aerator.
   h. Drain: Grid.
   i. Tempering Device: Thermostatic.

2.03 WATER CLOSETS

A. Water Closets, Floor mounted-flushvalve:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Inc. 3043.001 (ADA), 2234.001 (standard) or equal by
         1) Briggs Plumbing Products, Inc.
         2) Crane Plumbing, L.L.C./Fiat Products.
         3) Eljer.
         4) Kohler Co.
         5) TOTO USA, Inc.
         6) Sloan
         7) Zurn.
   2. Description: Accessible where indicated on drawings, Floor-mounting, floor-outlet, vitreous-china fixture designed for flushometer valve operation.
         1) Bowl Type: Elongated front with siphon-jet design. Include bolt caps matching fixture.
         2) Height: Accessible where indicated on drawings.
         3) Design Consumption: 1.6 gal./flush.
         4) Color: White.

2.04 TOILET SEATS

A. Toilet Seats:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Comfort seats C108SSCAM or equal.
      b. American Standard Companies, Inc.
      c. Bemis Manufacturing Company.
      d. Church Seats.
      e. Eljer.
      f. Kohler Co.
      g. Olsonite Corp.
   2. Description: Toilet seat for water-closet-type fixture.
      a. Material: Molded, heavy duty, solid, anti-microbial plastic.
      b. Configuration: Open front without cover.
      c. Hinge Type: Stainless Steel, self-sustaining.
      d. Class: Standard commercial.
      e. Color: White.

2.05 FLUSHOMETERS-WATER CLOSETS

A. Flushometers, Water Closets:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Coyne & Delany Co.
      b. Sloan Valve Company.
      c. Zurn Plumbing Products Group.
      d. Prior approved equal
   2. Description: Flushometer for water closet fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
      a. Internal Design: Diaphragm operation.
      b. Style: Exposed.
      c. Inlet Size: NPS 1".
      d. Trip Mechanism: Battery-operated sensor actuator.
      e. Consumption: 1.6 gal./flush.

2.06 URINALS

A. Urinals:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Inc.
      b. Crane Plumbing, L.L.C./Fiat Products.

c. Eljer.
d. Kohler Co.
e. Sloan
f. TOTO USA, Inc.
g. Zurn.
h. Prior approved equal.

2. Description: Accessible, where indicated on drawings, Wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
   a. Type: Blowout with extended shields.
   b. Strainer or Trapway: Open trapway with integral trap.
   c. Design Consumption: 1 gal./flush.
   d. Color: White.
   e. Supply Spud Size: NPS 3/4.
   f. Outlet Size: NPS 1-1/2.

2.07 FLUSHOMETERS-URINALS

A. Flushometers, Urinals:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Coyne & Delany Co.
      b. Sloan Valve Company.
      c. Zurn Plumbing Products Group.
      d. Prior approved equal
   2. Description: Flushometer for urinal-type fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
      a. Internal Design: Diaphragm operation.
      b. Style: Exposed.
      c. Inlet Size: NPS 3/4.
      d. Trip Mechanism: Battery-operated sensor actuator.
      e. Consumption: 1.0 gal./flush.

2.08 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Josam Company.
   2. MIFAB Manufacturing Inc.
   3. Smith, Jay R. Mfg. Co.
   4. Tyler Pipe; Wade Div.

5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.
7. Prior approved equal.

B. Water-Closet Supports:
   1. Description: Combination carrier designed for accessible or standard mounting height as required of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

C. Urinal Supports:
   1. Description: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.
   2. Accessible-Fixture Support: Include rectangular steel uprights.

D. Lavatory Supports:
   1. Description: Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
   2. Accessible-Fixture Support: Include rectangular steel uprights.

E. Sink Supports:
   1. Description: Type II, sink carrier with hanger plate, bearing studs, and tie rod for sink-type fixture. Include steel uprights with feet.

2.09 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Piping Enclosures:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. TRUEBRO, Inc.
      b. Plumberex.
      c. McGuire.
      d. Proflo.
      e. Prior approved equal.
   2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

2.10 COMMERCIAL SINKS

A. Commercial Sinks, Single Compartment Break Room Sink:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Elkay Manufacturing Co.
      b. Just Manufacturing Company.

c. Prior approved equal.

2. Description: One-compartment, counter-mounting, stainless-steel commercial sink with backsplash.
   a. Overall Dimensions: See drawings.
   b. Metal Thickness: 18 Gauge.
   c. Compartment:
      1) Drain: NPS 1-1/2 tailpiece with stopper.
   d. Location: Centered in compartment.

2.11 SINK FAUCETS

A. Sink Faucets One compartment :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Inc.
   b. Bradley Corporation.
   c. Chicago Faucets.
   d. Delta Faucet Company.
   e. Eljer.
   f. Elkay Manufacturing Co.
   g. Fisher Manufacturing Co.
   h. Just Manufacturing Company.
   i. Kohler Co.
   j. Moen, Inc.
   k. Sayco; a Briggs Plumbing Products, Inc. Company.
   l. Speakman Company.
   m. T & S Brass and Bronze Works, Inc.
   n. Zurn Plumbing Products Group.
2. Description: Kitchen faucet without spray. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
   a. Body Material: Commercial, solid brass.
   b. Finish: Polished chrome plate.
   c. Maximum Flow Rate: 2.5 gpm, unless otherwise indicated.
   d. Mixing Valve: Single control.
   e. Mounting: Deck.
   f. Handle(s): Lever.
   g. Spout Type: Swing, solid brass.
   h. Spout Outlet: Aerator.
   i. Drain: basket strainer

2.12 SERVICE SINKS

A. Service Sinks:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Inc.
      b. Commercial Enameling Company.
      c. Eljer.
      d. Kohler Co.
   2. Description: Floor-mounting, enameled, cast-iron fixture with front apron, raised back, and coated, wire rim guard.
      a. Size: 28 by 28 inches.
      b. Color: White.
      c. Faucet: Sink American Standard 8344.111 with threaded spout and48 inch hose and damp or equal by
         1) Eljer.
         2) Kohler.
         3) Speakman.
      d. Drain: Grid with NPS 2 outlet.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
   1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
   2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
   3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to roughing-in drawings.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
   1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 and 23 Section "Valves."

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

N. Install toilet seats on water closets.

O. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

P. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

Q. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

R. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

S. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

T. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 and 23 Section "Basic Mechanical Materials and Methods."

U. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.04 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.05 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust all fixtures. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

D. Replace washers and seals of leaking and dripping faucets and stops.

E. Install fresh batteries in sensor-operated mechanisms.

3.06 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
   1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
   2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.07 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 45 00

EMERGENCY PLUMBING FIXTURES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Eyewash equipment.
   2. Combination units.

1.03 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.

D. Tepid: Moderately warm.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For emergency plumbing fixtures to include in operation and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."

C. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.

D. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities" for plumbing fixtures for people with disabilities.

PART 2 PRODUCTS

2.01 EYEWASH EQUIPMENT

A. Sink, Swivel-Type, Plumbed Eyewash Unit,:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Acorn Safety; a division of Acorn Engineering Company.
      b. Bradley Corporation.
      c. Guardian Equipment Co.
      d. Haws Corporation.
      e. Prior approved equal
   2. Capacity: Not less than 0.4 gpm for at least 15 minutes.
   3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   4. Control-Valve Actuator: Movement of spray-head assembly to position over sink.
   5. Spray-Head Assembly: Two spray heads with offset piping.
   6. Mounting: Deck next to sink.

2.02 COMBINATION UNITS

A. Standard, Plumbed Emergency Shower with Eyewash Combination Units,:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Acorn Safety; a division of Acorn Engineering Company.
      b. Bradley Corporation.
      c. Guardian Equipment Co.
      d. Haws Corporation.
      e. Prior approved equal.
   2. Piping:
      a. Material: PVC.
      b. Unit Supply: NPS 1-1/2 (DN 40).
      c. Unit Drain: Outlet at back or side near bottom.
   3. Shower:
      a. Capacity: Not less than 20 gpm for at least 15 minutes.
      b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
      c. Control-Valve Actuator: Pull rod.
      d. Shower Head: 8-inch- minimum diameter, plastic.
      e. Mounting: Pedestal.

4. Eyewash Unit:
    a. Capacity: Not less than 0.4 gpm for at least 15 minutes.
    b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
    c. Control-Valve Actuator: Paddle.
    d. Spray-Head Assembly: Two receptor-mounted spray heads.
    e. Receptor: Plastic bowl.
    f. Mounting: Attached shower pedestal.
    g. Drench-Hose Option: May be provided instead of eyewash unit.
        1) Capacity: Not less than 0.4 gpm for at least 15 minutes.
        2) Drench Hose: Hand-held spray head with squeeze-handle actuator and hose.
        3) Mounting: Bracket on shower pedestal.

2.03 WATER-TEMPERING EQUIPMENT

A. Hot- and Cold-Water, Water-Tempering Equipment,:
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. Acorn Safety; a division of Acorn Engineering Company.
        b. Armstrong International, Inc.
        c. Bradley Corporation.
        d. Guardian Equipment Co.
        e. Haws Corporation.
        f. Lawler Manufacturing Co., Inc.
        g. Leonard Valve Company.
        h. Powers; a division of Watts Water Technologies, Inc.
        i. Speakman Company.
        j. Prior approved equal
    2. Description: Factory-fabricated equipment with thermostatic mixing valve.
        a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
        b. Supply Connections: For hot and cold water.

2.04 SOURCE QUALITY CONTROL

A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 EMERGENCY PLUMBING FIXTURE INSTALLATION

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures. Use ball, gate, or globe valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Division 22 and 23 Section "General-Duty Valves for Plumbing Piping."

1. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
2. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.

E. Install shutoff valve and strainer in steam piping and shutoff valve in condensate return piping. Comply with requirements for steam and condensate piping specified in Division 22 and 23 Section "Steam and Condensate Piping."

F. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Division 22 and 23 Section "Domestic Water Piping."

G. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Division 22 and 23 Section "Meters and Gages for Plumbing Piping."

H. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Division 22 and 23 Section "Sanitary Waste and Vent Piping."

I. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Division 22 and 23 Section "Sanitary Waste and Vent Piping."

J. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Division 22 and 23 Section "Escutcheons for Plumbing Piping."

K. Fill self-contained fixtures with flushing fluid.

3.03 CONNECTIONS

A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Division 22 and 23 Section "Domestic Water Piping."

B. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Division 22 Section "Domestic Water Piping."

C. Connect steam and cold-water-supply and condensate return piping to steam and cold water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for cold-water piping specified in Division 22 Section "Domestic Water Piping" and comply with requirements for steam and condensate piping specified in Division 22 and 23 Section "Steam and Condensate Piping."

D. Connect cold water and electrical power to electric heating water-tempering equipment. Comply with requirements for cold-water piping specified in Division 22 Section "Domestic Water Piping."

E. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Division 22 Section "Sanitary Waste and Vent Piping."

F. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.

G. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.04 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Division 22 and 23 Section "Identification for Plumbing Piping and Equipment."

3.05 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection.
   2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.06 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.

B. Adjust equipment temperature settings.

END OF SECTION

SECTION 23 01 00

GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 GENERAL

A. General Conditions and Division 01 apply to this Division.

1.02 SCOPE

A. Includes:
   1. Furnish all labor, materials, and equipment necessary for the completion of the mechanical and plumbing scope of work.
   2. Furnish and install all motors specified in this Division and be responsible for the proper operation of electrical powered equipment furnished by this Division.
   3. Furnish exact location of electrical connections and information on motor controls to Division 26.
   4. Mechanical Contractor shall obtain the services of independent Test and Balance Agency.
   5. Placing the air conditioning, heating, ventilating, and exhaust systems into full operation and continuing their operation during each working day of testing and balancing.
   6. Making changes in pulleys, belts, and dampers, or adding dampers, as required for the correct balance as recommended by Balancing Contractor at no additional cost to Owner.
   7. Air balance, final adjustment and test run.
   8. The satisfactory performance of the completed systems is a requirement of this specification.

B. Related Work Specified Elsewhere
   1. Conduit, line voltage wiring, outlets, and disconnect switches specified in Division 26.
   2. Magnetic starters and thermal protective devices (heaters) not a factory mounted integral part of packaged equipment are specified in Division 26.

1.03 SITE OBSERVATION

A. The Contractor shall examine the site and understand the conditions which may affect the performance of work of this Division before submitting proposals for this work.

B. No subsequent allowance for time or money will be considered for any consequence related to failure to examine existing site conditions.

1.04 DRAWINGS

A. Mechanical drawings show general arrangement of piping, ductwork, equipment, etc; however, locations are to be regarded as shown diagrammatically only. Follow as closely as actual building construction and work of other trades will permit.

B. Because of the small scale of mechanical drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Investigate existing structural and finished conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions.

C. If changes in location of piping, equipment, ducts, etc. are required due to lack of coordination of work under this division, such changes shall be made without charge. Contractor shall review drawings with local and state agencies having jurisdiction and any changes required by them shall be brought to the attention of the Engineer prior to bidding or commencement of work. It is understood that while Drawings are to be followed as closely as circumstances permit, this Division will be held responsible for the installation of systems according to the true intent and meaning of the Contract Documents. Anything not clear or in conflict will be explained by making application to the Engineer in writing. Should conditions arise where certain changes would be advisable, secure Owner's and Engineer approval for these changes before proceeding with work.

1.05 COORDINATION OF WORK:

A. Coordinate work of various trades in installing interrelated work. Before installation of mechanical items, make proper provision to avoid interferences in a manner approved by Engineer. Changes required in work specified in Division 22 and 23 caused by neglect to secure approval shall be made at no cost to Owner.

B. Arrange piping, ductwork, and equipment to permit ready access to valves, unions, starters, motors, control components, and to clear openings of doors and access panels. Contractor shall provide all necessary access doors and/or panels to provide complete access to all mechanical equipment, dampers, or accessories. Doors for dampers, etc. shall be minimum 12" x 12" and doors for mechanical equipment shall be minimum 24" x 24".

C. Furnish and install inserts and supports required by Division 22 and 23 unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions involved in sufficient time to be built into the construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne by Contractor.

D. Be responsible for required digging, cutting, and patching incident to work of this Division and make required repairs afterwards to satisfaction of Owner and Architect. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses.
   1. Patch and repair walls, floors and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
   2. This Division shall bear expense of cutting, patching, repairing, and replacing of work of other Divisions because of its fault, error, tardiness, or because of damage done by it.
   3. Provide the necessary cutting, patching, repairing, and replacing pavements, sidewalks, etc. to permit installation of work of this Division.

E. Adjust locations of piping, ductwork, equipment, etc, to accommodate work from interferences anticipated and encountered. Determine exact route and location of each pipe and cut prior to fabrication.

1. Make offsets, transitions, and changes in direction of piping, ductwork, and electrical raceways as required to maintain proper head room and pitch of sloping lines whether or not indicated on Drawings.

F. Slots and openings through floors, walls and roofs shall be provided by this Division.

G. This Contractor shall schedule his work, store his equipment and materials, and work in harmony with other Contractors so as to not delay or jeopardize the construction.

H. This Division shall coordinate with electrical contractor to insure that all required components of control work are included and fully understood. Any discrepancies shall be called to the attention of the Engineer before completion of bids. No additional cost shall accrue to the Owner as a result of lack of such coordination.

1.06 EQUIPMENT & MATERIALS:

A. Requests for substitution shall be received in writing a minimum of seven days prior to bidding. Prior acceptance shall be by Manufacturer's name only. Items not listed in this specification or subsequent addendums shall not be considered. No oral approvals will be acceptable. Manufacturers listed in this specification are acceptable only for items listed. All other items manufacturer wishes to bid must be prior approved. All equipment shall be subject to final review in accordance with "Project Submittals".

B. Product Approvals -

1. If approval is received to use other than specified items, responsibility for specified capacities and insuring that items to be furnished will fit space available lies with this Division.
2. In the event other than specified equipment is used and will not fit job site conditions, this Division assumes responsibility for replacement with items named in Specification.

C. Use <u>domestic made</u> pipe, pipe fittings, and motors on Project.

D. Motor and equipment name plates as well as applicable UL labels shall be in place when Project is turned over to Owner.

E. Insure that items to be furnished fit spaces available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents. Do not scale off drawings.

F. All materials shall be of the best commercial quality obtainable, consistent with specified materials and for the purpose or function intended. Materials shall be new unless specifically excepted.

G. Equipment catalog or model numbers shown define the basic equipment types and quality standard only. Catalog numbers shall not be considered as all inclusive and shall

be verified to include all devices, controls, operators, and appurtenances necessary for the satisfactory and complete operation of the equipment.

H. Follow manufacturer's directions in delivery, storage, protection, and installation of equipment and materials.
   1. Promptly notify Engineer in writing of conflicts between requirements of Contract Documents and Manufacturer's directions and obtain Engineer's written instructions before proceeding with work. Contractor shall bear all expenses arising from correcting deficiencies of work that does not comply with Manufacturer's directions or such written instructions.

I. Deliver equipment and material to site and tightly cover and protect against dirt, water, and chemical or mechanical injury but have readily accessible for inspection. Store items subject to moisture damage (such as controls) in a dry, heated space.

1.07 PROJECT SUBMITTALS:

A. Provide submittals per Section 01 33 00 Submittal Procedures.

B. Submittal shall include, but not be limited to the following:
   1. equipment scheduled
   2. balancing contractor
   3. insulation
   4. grilles, and diffusers
   5. automatic temperature controls
   6. certificates of guarantee
   7. valves
   8. plumbing fixtures, accessories, and specialties
   9. any item for which more than one manufacturer is mentioned

C. If material or equipment is not as specified or submittal is not complete, it will be rejected.

D. Catalog data or shop drawings for equipment which are noted as approved shall not supersede Contract Documents.

E. Review comments shall not relieve this Division from responsibility for deviations from Contract Documents unless attention has been called to such deviations in writing at time of submission, nor shall they relieve this Division from responsibility for errors in items submitted.

F. Check work described by catalog data with Contract Documents for deviations and errors.

G. All items other than first named specified equipment shall show and state all exceptions and deviations taken and shall include design calculations and drawing layouts.

H. Contractor shall verify equipment dimensions to fit the spaces provided with sufficient clearance for servicing the equipment.

I. Contractor shall review equipment submittals for compliance with schedules, specifications, and drawing plans and details. Equipment submittal shall show the proper arrangements to suit installation and maintenance such as motor location, access doors, filter removal, piping connections, etc.

J. Equipment submittal sheets shall be clearly marked indicating equipment symbol and exact selection of proposed equipment. Submittals shall clearly indicate name of manufacturer of each item.

1.08 CLEANING & FINISHING:

A. Contractor shall, at all times, keep the premises free from waste material and rubbish. Upon completion of this Section of the work, Contractor shall remove all surplus materials and rubbish; clean all spots resulting from the mechanical work from hardware, floors, glass, walls, etc.; do all required patching up and repair all work of other trades damaged by Contractor under this Section of the work, and leave the premises in a clean orderly condition. Clean heating and cooling coils, internally and externally, and replace all air filters prior to final mechanical inspection. Remove rust, plaster, dirt, grease and oil before painting, insulating, or exposing to view the equipment, piping, ductwork, etc. in completed structure. Refinish any damaged surfaces and leave in proper working order at final completion.

1.09 EQUIPMENT SERVICING:

A. Prior to starting mechanical equipment, all motors, bearings and moving parts shall be properly oiled, greased and lubricated as required. Full and adequate maintenance service shall be given and upon completion all equipment shall be cleaned and checked and placed in perfect condition for the Owner.

B. Amount and type of lubricant shall be per manufacturer's specification.

1.10 SUPERVISION:

A. The Contractor shall supervise and direct the work with his best skill and attention. He will be solely responsible for the means, methods, techniques, sequences and procedures of construction. The Contractor will be responsible to see that the finished work complies accurately with the Contract Documents.

1.11 SAFETY REGULATIONS:

A. Contractor shall provide equipment, supervision, construction, procedures, and everything necessary to assure safety of life or property.

B. Refer also to General Condition and Special Conditions for protection clauses.

1.12 LEAK DAMAGE:

A. Contractor shall be responsible for damages to the work of other Contractors or to the building, or to its contents, people, etc., caused by leaks in any of the equipment or piping installed by him through equipment or material failures, leaking joints or disconnected pipes, fittings, or by overflows and shall make at his own expense all

repairs to fixtures, building interior, contents, paint, rugs, furniture, ceiling tile, and equipment so damaged.

1.13 TOOLS AND STORAGE OF EQUIPMENT:

A. The Contractor shall furnish all necessary tools, staging and whatever may be necessary for the installation of this work and shall at all times protect this work and others, and the materials to be used therein from damage by the weather, accident and other causes, and shall repair and make good any damage thus occurring.

1.14 WORKMANSHIP:

A. Workmanship shall be the best quality of its kind for respective industries, trades, crafts and practices and shall be acceptable in every respect to the Owner and Engineer. Nothing contained herein shall relieve the Contractor from performing good work, perfect in all details of construction.

1.15 PAINTING BY CONTRACTOR:

A. All exposed, insulated, and bare piping, equipment, metal stands and supports shall be painted as follows:
   1. All equipment which is to be furnished in finished painted condition by Contractor shall be left without mark, scratch or impairment to finish upon completion and acceptance of job. Any necessary refinishing to match original shall be done by Contractor. Do not paint over name plates, serial numbers or other identifying marks.

1.16 BELT GUARDS:

A. Shall be provided, properly enclosing each belt drive system. Guards shall be easily removable, constructed of expanded metal with suitable frames corresponding with SMACNA standard and with tachometer openings. Coordinate with equipment suppliers to avoid duplication of belt guards supplied with equipment. Guards shall comply with OSHA Regulations.

1.17 ELECTRICAL WORK:

A. Power wiring to all electrically driven apparatus shall be done under the electrical contract. See Electrical Specifications.

B. Unless specifically noted otherwise on documents, Electrical Contractor shall furnish and install all magnetic starters including properly sized heaters, and disconnect switches as indicated on drawings or required by code.

C. The Contractor shall verify the proper operation of equipment furnished by him. Costs for repair, replacing, re-wiring and retesting shall be borne by the Contractor without additional costs to the Owner.

D. Motors shall be as specified.

1.18 CONTRACTOR'S USE OF BUILDING EQUIPMENT:

A. The Contractor may use equipment such as electric motors, fans, filters, etc. when permanently installed as part of the project and with the written permission of the Owner. As each piece of equipment is used, maintenance procedures approved by the manufacturer shall be followed, a careful record shall be kept of the time used, maintenance procedure following and of any difficulty experienced with equipment. The Contractor's records on the equipment shall be submitted to the Owner upon acceptance of project. All fan belts and filter media shall be new at the beginning of the Mechanical System Operating Test Run and System Balancing. Wearing surfaces (such as bearings) shall be carefully inspected just prior to acceptance. Any excessive wear noted shall require replacement.

1.19 INSPECTION NOTICE:

A. The following is a basic list of guideline items so that the Architect, district building inspector/Owner's representative can be at job site for these inspections as the building progresses. Mechanical Contractor shall inform these people one week in advance of test time.
   1. Water tests on all sewer, waste, and rainwater piping prior to piping being concealed.
   2. Pressure tests on all water service piping.
   3. Pressure tests on hot, chilled, and condenser water supply and return piping.
   4. All duct work prior to installation of finished ceilings, including ductwork pressure testing.
   5. The initial start-up of mechanical equipment, etc.
   6. Any changes or problems occurring at job site.
   7. Inspect all vent flashings on roof prior to roofing.
   8. Periodic inspection at their discretion will be made to insure compliance to Contract Documents and codes. Contractor shall provide ladders, access and other assistance as requested during inspections.
   9. Control piping pressure tests.
   10. Final inspection before giving approval for final payment.

1.20 WARRANTY GUARANTEE:

A. The Contractor shall warrant all materials and equipment to be of quality consistent with specifications Division 01.

B. Substantial completion and acceptance in no way relieves the Contractor from providing the systems and equipment as specified.

1.21 COMPLETION SCHEDULE:

A. Start-up and verification of basic equipment items shall be done prior to the date of substantial completion with sufficient time to allow balancing and adjusting to be performed.

B. At the time of the final inspection a date shall be agreed upon for completion of any remaining items. At least double the estimated cost of the work will be withheld from the Contractor's payment.

1.22 CODE REQUIREMENTS, FEES, AND PERMITS

A. The work shall be installed in accordance with the following applicable codes, ordinances and standards unless otherwise specified. The codes and standards shall include but not be limited to and be of the latest and current editions.
   1. American Boiler and Affiliated Industries (AB and AI)
   2. American Gas Association (AGA)
   3. Air Movement and Control Association (AMCA)
   4. American National Standards Institute (ANSI)
   5. Air Conditioning & Refrigeration Institute (ARI)
   6. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) - ASHRAE 90.1-2019
   7. American Society of Mechanical Engineers (ASME)
   8. American Society of Testing Materials (ASTM)
   9. American Standards Association (ASA)
   10. American Water Works Association (AWWA)
   11. American Welding Society (AWS)
   12. Associated Air Balance Council (AABC)
   13. Heat Exchange Institute (HEI)
   14. Hydraulic Institute (HI)
   15. BR
   16. National Electrical Code (NEC)
   17. National Fire Protection Association (NFPA)
   18. Sheet Metal and Air Conditioning contractors National Association (SMACNA)
   19. Underwriters Laboratories (UL)
   20. International Building Code (IBC) 2021 Ed
   21. International Mechanical Code (IMC) 2021 Ed
   22. International Plumbing Code (IPC) with Utah Amendments 2021 Ed
   23. International Energy Conservation Code (IECC) 2021 Ed
   24. Utah State Safety Orders (OSHA/UOSH)
   25. Utah Fire Rating Bureau
   26. Utah Boiler and Pressure Vessel Law
   27. Utah Air Conservation Regulations/Waste Disposal regulations.
   28. ASHRAE Ventilation STD.62-2019

B. Should drawings conflict with any code, the code shall govern. If drawings and specifications establish a quality exceeding the code, the drawings and specifications shall govern. If conflicts do exist among the drawings, specifications and codes, the same shall be brought to the attention of the Engineer in writing prior to bidding, otherwise Contractor shall comply with applicable codes.

C. The latest edition of all codes shall be used.

D. Contractor shall give all notices, obtain all necessary permits, file necessary plans, prepare documents and obtain approvals, and pay all fees required for completion of the mechanical and plumbing work outlined in this Division of the specifications and shown on the Mechanical Drawings.

1.23 OPERATION AND MAINTENANCE MANUAL FOR MECHANICAL SYSTEMS

A. Upon completion of work provide operation and maintenance manuals per Division 01.

1.24 OPERATION AND MAINTENANCE INSTRUCTIONS

A. Contractor shall instruct building maintenance personnel in the operation and maintenance of the installed mechanical systems per Division 01.

B. Minimum instruction periods shall be as follows -
   1. Mechanical HVAC - Four hours.
   2. Temperature Control - Four hours.

C. Instruction periods shall occur before final site observation when systems are properly working and before final payment is made.

D. None of these instructional periods shall overlap each other.

E. An additional four hours of instruction will be provided by each contractor, after 60 days of system operation by owner to insure proper system operation and answer questions.

1.25 RECORD DRAWINGS

A. Contractor shall keep an up-to-date set of mechanical and plumbing drawings per Division 01.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

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SECTION 23 05 00

BASIC PLUMBING AND HVAC MATERIALS AND METHODS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:
   1. Mechanical demolition.
   2. Equipment installation requirements common to equipment sections.

1.03 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
   1. ABS: Acrylonitrile-butadiene-styrene plastic.
   2. CPVC: Chlorinated polyvinyl chloride plastic.
   3. PVC: Polyvinyl chloride plastic.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.05 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

PART 2 PRODUCTS

2.01 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Stamped-Steel Type: With set screw or spring clip**s** and chrome-plated finish.

2.02 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 MECHANICAL DEMOLITION

A. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
   3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
   4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
   5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

B. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.02 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

END OF SECTION

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SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.03 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Comply with IEEE 841 for severe-duty motors.

2.02 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.03 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.05 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.

2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

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SECTION 23 05 48

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:
   1. Isolation pads.
   2. Freestanding and restrained spring isolators.
   3. Seismic snubbers.
   4. Restraining braces and cables.

1.03 SCOPE

A. Provide letter of design intent.

B. Provide full set of seismic submittals.

C. Provide final letter of compliance completion.

1.04 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

1.05 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:
   1. Basic Wind Speed: Per owner's design standards.
   2. Building Classification Category: As defined in the IBC.
   3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

B. Seismic-Restraint Loading:
   1. Site Class: As defined in the IBC.
   2. Assigned Seismic Use Group or Building Category: As defined in the IBC.
      a. Component Importance Factor: 1.0.

1.06 SUBMITTALS

A. Product Data: For the following:
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.
   3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Letter of Design intent, stating company, design criteria, compliance with specifications and only exceptions that will apply. Letter shall be stamped and signed by a licensed and qualified professional engineer in this jurisdiction.

C. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.
      a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 22 and 23 Sections for equipment mounted outdoors.
   2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
   3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
   4. Seismic- and Wind-Restraint Details:
      a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
      b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacing's. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
      c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 22 and 23 Sections for equipment mounted outdoors.

d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

D. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

E. Welding certificates.

F. Qualification Data: For professional engineer and testing agency.

G. Field quality-control test reports.

1.07 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

E. Upon project completion provide a final letter of acceptance for seismic restraints system and installation.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amber/Booth Company, Inc.
   2. Vibro-acoustics.
   3. ISAT
   4. Mason Industries.
   5. Caddy

6. Prior approved equal.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
   1. Resilient Material: Oil- and water-resistant neoprene or rubber.

C. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
   1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
   3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.02 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amber/Booth Company, Inc.
   2. Hilti, Inc.
   3. ISAT
   4. Kinetics Noise Control.
   5. Mason Industries.
   6. Vibro-acoustics.
   7. Unistrut; Tyco International, Ltd.
   8. Prior approved equal.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
   1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
   1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
   2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.

3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Restraint Cables: -steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.

G. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

J. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

K. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.03 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
   1. Powder coating on springs and housings.
   2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
   3. Baked enamel or powder coat for metal components on isolators for interior use.
   4. Color-code or otherwise mark vibration isolation and seismic- and wind-control devices to indicate capacity range.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.03 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:
   1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
   2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
   3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. Piping Restraints:
   1. Comply with requirements in MSS SP-127.
   2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
   3. Brace a change of direction longer than 12 feet.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

H. Drilled-in Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
   5. Set anchors to manufacturer's recommended torque, using a torque wrench.
   6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Leave a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:
   1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.06 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust air-spring leveling mechanism.

D. Adjust active height of spring isolators.

E. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR MECHANICAL AND PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:
   1. Equipment nameplates.
   2. Equipment signs.
   3. Access panel and door markers.
   4. Pipe markers.
   5. Warning tags.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.04 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.05 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.01 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
   1. Data:
      a. Manufacturer, product name, model number, and serial number.
      b. Capacity, operating and power characteristics, and essential data.
      c. Labels of tested compliances.
   2. Location: Accessible and visible.
   3. Fasteners: As required to mount on equipment.

B. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
   1. Data: Instructions for operation of equipment and for safety procedures.
   2. Engraving: Manufacturer's standard letter style, 1/4” or larger with terms to match equipment identification.
   3. Thickness: 1/8 inch, unless otherwise indicated.
   4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

C. Access Panel and Door Markers: 1/16” thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8” center hole for attachment.
   1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.02 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Bradley.
      b. Kolbi.
      c. Prior approved.
   2. Colors: Comply with ASME A13.1, unless otherwise indicated.
   3. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
   4. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
   5. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
   6. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

PART 3 EXECUTION

3.01 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 22 and 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.02 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
   1. Fuel-burning units, including boilers, furnaces, heaters, etc.
   2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
   3. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
   4. Fans, blowers, primary balancing dampers, and mixing boxes.
   5. Packaged HVAC central-station and zone-type units.

B. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.
   1. Identify mechanical equipment with black equipment markers with white lettering.
   2. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
   4. Include signs for the following general categories of equipment:
      a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
      b. Fuel-burning units, including boilers, furnaces, heaters, etc.
      c. Pumps, compressors, chillers, condensers, and similar motor-driven units.
      d. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
      e. Fans, blowers, primary balancing dampers, and mixing boxes.
      f. Packaged HVAC central-station and zone-type units.
      g. Tanks and pressure vessels.
      h. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

C. Install access panel markers with screws on equipment access panels.

3.03 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

C. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.04 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.05 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Coordinate with section 01 91 00 Commissioning, testing, and startup.

1.02 SUMMARY

A. This Section includes TAB to produce design objectives for the following:
   1. Air Systems:
      a. Constant-volume air systems.
   2. HVAC equipment quantitative-performance settings.
   3. Existing systems TAB.
   4. Verifying that automatic control devices are functioning properly.
   5. Reporting results of activities and procedures specified in this Section.

1.03 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room criteria.

H. Report Forms: Test data sheets for recording test data in logical order.

I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

M. TAB: Testing, adjusting, and balancing.

N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

O. Test: A procedure to determine quantitative performance of systems or equipment.

P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.04 SUBMITTALS

A. Qualification Data: Within 15 days from Contractor's Notice to Proceed, submit 4 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days from Contractor's Notice to Proceed, submit 4 copies of the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit 4 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.

D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

E. Sample Report Forms: Submit two sets of sample TAB report forms.

F. Warranties specified in this Section.

1.05 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by AABC or NEBB.

B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:
    a. Submittal distribution requirements.

b. The Contract Documents examination report.
c. TAB plan.
d. Work schedule and Project-site access requirements.
e. Coordination and cooperation of trades and subcontractors.
f. Coordination of documentation and communication flow.

C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.06 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.07 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.08 WARRANTY

A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

L. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

M. Examine strainers for clean screens and proper perforations.

N. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

O. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

P. Examine system pumps to ensure absence of entrained air in the suction piping.

Q. Examine equipment for installation and for properly operating safety interlocks and controls.

R. Examine automatic temperature system components to verify the following:
   1. Dampers, valves, and other controlled devices are operated by the intended controller.
   2. Dampers and valves are in the position indicated by the controller.
   3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
   4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
   5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
   6. Sensors are located to sense only the intended conditions.
   7. Sequence of operation for control modes is according to the Contract Documents.
   8. Controller set points are set at indicated values.
   9. Interlocked systems are operating.
   10. Changeover from heating to cooling mode occurs according to indicated values.

S. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:
   1. Permanent electrical power wiring is complete.
   2. Hydronic systems are filled, clean, and free of air.
   3. Automatic temperature-control systems are operational.
   4. Equipment and duct access doors are securely closed.
   5. Balance, smoke, and fire dampers are open.
   6. Isolating and balancing valves are open and control valves are operational.
   7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
   8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling unit components.

L. Check for proper sealing of air duct system.

3.05 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure fan static pressures to determine actual static pressure as follows:
      a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
      b. Measure static pressure directly at the fan outlet or through the flexible connection.
      c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
      d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
   2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
      a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
   3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
   4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
   5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.

6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
   1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
      a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
   2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.
   1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
   1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
   2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.06 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.07 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
   1. Include a list of instruments used for procedures, along with proof of calibration.

C. Provide final report on standard AABC or NEBB forms.

3.08 INSPECTIONS

A. Initial Inspection:
   1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
   2. Randomly check the following for each system:
      a. Measure airflow of at least 10 percent of air outlets.
      b. Measure water flow of at least 5 percent of terminals.
      c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
      d. Measure sound levels at two locations.
      e. Measure space pressure of at least 10 percent of locations.
      f. Verify that balancing devices are marked with final balance position.
      g. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:
   1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
   2. TAB firm test and balance engineer shall conduct the inspection in the presence of Architect.
   3. Architect shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
   4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
   5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
   6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
   7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.09 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 07 00

HVAC AND PLUMBING INSULATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Insulation Materials:
      a. Mineral fiber.
   2. Insulating cements.
   3. Adhesives.
   4. Lagging adhesives.
   5. Factory-applied jackets.
   6. Field-applied jackets.
   7. Tapes.
   8. Securements.
   9. Corner angles.

B. Related Sections:
   1. Division 23 Section "Metal Ducts" for duct liners.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Qualification Data: For qualified Installer.

C. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

D. Field quality-control reports.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.06 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 and 23 Section "Hangers and Supports."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.07 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Duct insulation shall have a minimum R value = 5 for installation in an unconditioned space, and a minimum R value = 8 for installation outdoors. Provide a weather protective sheet metal jacket for outdoor installation.
   2. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; Duct Wrap.
      b. Johns Manville; Microlite.
      c. Knauf Insulation; Duct Wrap.
      d. Manson Insulation Inc.; Alley Wrap.
      e. Owens Corning; All-Service Duct Wrap.
      f. Prior approved equal.

G. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Fibrex Insulations Inc.; Coreplus 1200.
      b. Johns Manville; Micro-Lok.
      c. Knauf Insulation; 1000 Pipe Insulation.
      d. Manson Insulation Inc.; Alley-K.
      e. Owens Corning; Fiberglas Pipe Insulation.
      f. Prior approved equal.
   2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A.

2.02 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Insulco, Division of MFS, Inc.; Triple I.
      b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.
      c. Prior approved equal.

2.03 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-127.
      b. Foster Products Corporation, H. B. Fuller Company; 85-60/ 85-70.
      c. Marathon Industries, Inc.; 225.
      d. Mon-Eco Industries, Inc.; 22-25.
      e. Prior approved equal.

2.04 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of H.B. Fuller; CR 50 AHV2.
      b. Foster Products Corporation, H. B. Fuller Company; 30-36.
      c. Vimasco Corporation; 713 and 714.
      d. Prior approved equal.
   2. Service Temperature Range: Minus 50 to plus 180 deg F.
   3. Color: White.

2.05 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.06 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
      b. Compac Corp.; 104 and 105.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
      e. Prior approved equal.
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      b. Compac Corp.; 110 and 111.

c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
e. Prior approved equal.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
8. Adhesion: 64 ounces force/inch in width.
9. Elongation: 500 percent.
10. Tensile Strength: 18 lbf/inch in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
b. Compac Corp.; 120.
c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
d. Venture Tape; 3520 CW.
e. Prior approved equal.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.07 SECUREMENTS

A. Bands:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products; Bands.
b. PABCO Metals Corporation; Bands.
c. RPR Products, Inc.; Bands.
d. Prior approved equal.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

2.08 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Manholes.
   5. Handholes.
   6. Cleanouts.

3.04 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
   6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
   7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.05 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
      b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
      c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      d. Do not overcompress insulation during installation.
      e. Impale insulation over pins and attach speed washers.
      f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.06 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
    1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.07 FIELD QUALITY CONTROL

A. Tests and Inspections:
    1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
    2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
    3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.08 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
   1. Indoor, concealed supply and outdoor air.
   2. Indoor, exposed supply and outdoor air.
   3. Indoor, concealed return, Air.
   4. Indoor, exposed return, Air.
   5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
   6. Indoor, concealed exhaust.
   7. Indoor, exposed exhaust.

B. Items Not Insulated:
   1. Fibrous-glass ducts.
   2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
   3. Factory-insulated flexible ducts.
   4. Factory-insulated plenums and casings.
   5. Flexible connectors.
   6. Vibration-control devices.
   7. Factory-insulated access panels and doors.

3.09 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval duct insulation shall be the following:
   1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

B. Concealed, low pressure, round rectangular, and flat-oval exhaust-air duct insulation shall be the following:
   1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

C. Rectangular, low pressure, supply-air duct insulation shall be lined per Section “Metal Ducts”.

D. Rectangular, return-air duct insulation shall be lined per Section “Metal Ducts”.

E. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.

F. Exposed or medium pressure, round and flat-oval, supply-air, and return air duct insulation shall be a perforated linear. See Section “Metal Ducts”.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
   4. Vertical roof drain piping.

C. Piping System insulation:
   1. Hydronic Piping - Mineral Fiber, per chart.
   2. Domestic Cold Water Piping -Mineral Fiber, ½"
   3. Domestic Hot Water Piping -Mineral Fiber, per chart
   4. Horizontal Roof Drain Piping - Mineral Fiber, 1/2".
   5. Refrigerant Piping - Flexible elastomeric, 1".

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Minimum Pipe Insulation Thickness from ANSI/ASHRAE/IESNA Standard 90.1-2016, with modifications per 2018 IECC

Fluid Operating Temperature Range and usage (F°)	Insulation Conductivity		Nominal Pipe or Tube Size (inches)				
	Conductivity Btu-in./(h-ft2-F°)	Mean Rating Temp. F°	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
Heating Systems (Steam, Steam Condensate, and Hot Water)							
>350	0.32-0.34	250	4.5	5.0	5.0	5.0	5.0
251-350	0.29-0.32	200	3.0	4.0	4.5	4.5	4.5
201-250	0.27-0.30	150	2.5	2.5	2.5	3.0	3.0
141-200	0.25-0.29	125	1.5	1.5	2.0	2.0	2.0
105-140	0.21-0.28	100	1.0	1.0	1.5	1.5	1.5
Cooling Systems (Chilled Water, Brine, and Refrigerant)							
40-60	0.21-0.27	75	0.5	0.5	1.0	1.0	1.0
<40	0.20-0.26	50	0.5	1.0	1.0	1.0	1.5

3.12 DUCT INSULATION SCHEDULE

A. Minimum Duct Insulation R-Value, Cooling and Heating Supply Ducts and Return Ducts ANSI/ASHRAE/IES Standard 90.1-2016.

Duct Location							
Climate Zone	Exterior	Ventilated Attic	Unvented Attic Above Insulated Ceiling	Unvented Attic with Roof Insulation	Unconditioned Space	Indirectly Conditioned Space	Buried
Heating- Only Ducts							
5	R-6	R-3.5	none	none	none	none	R-3.5
Cooling-Only Ducts							
5,6	R-3.5	R-1.9	R-3.5	R-1.9	R-1.9	none	none
Return Ducts							
1 to 8	R-3.5	R-3.5	R-3.5	none	none	none	none
Combine Heating and Cooling							
Supply Ducts							
5	R-6	R-6	R-6	R-1.9	R-3.5	none	R-3.5
Return Ducts							
1 to 8	R-3.5	R-3.5	R-3.5	none	none	none	none

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:
   1. PVC: 20 mils thick.

3.14 OUTDOOR, FIELD APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Exterior piping, Exposed:
   1. Aluminum jacket.

END OF SECTION

SECTION 23 09 00

INSTRUMENTATION AND CONTROLS FOR HVAC

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

B. Provide an independent control system for each building, with a BACNET interface to allow the opportunity for the owner to tie into a BAS for remote monitoring. This may include individual BACNET thermostats, or a central Jace.

1.03 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. MS/TP: Master slave/token passing.

D. PC: Personal computer.

E. PID: Proportional plus integral plus derivative.

F. RTD: Resistance temperature detector.

1.04 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

D. Qualification Data: For Installer and manufacturer.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with ASHRAE 135 for DDC system components.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.07 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 CONTROL SYSTEM

A. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

2.03 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Room sensor accessories include the following:
   1. Insulating Bases: For sensors located on exterior walls.

2.04 THERMOSTATS

A. Electric, solid-state, microcomputer-based room thermostat with remote sensor.
   1. Automatic switching from heating to cooling.
   2. Preferential rate control to minimize overshoot and deviation from set point.
   3. Set up for four separate temperatures per day.
   4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
   5. Short-cycle protection.
   6. Programming based on every day of week.
   7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
   8. Battery replacement without program loss.
   9. Thermostat display features include the following:
      a. Time of day.
      b. Actual room temperature.
      c. Programmed temperature.
      d. Programmed time.
      e. Duration of timed override.
      f. Day of week.
      g. System mode indications include "heating," "off," "fan auto," and "fan on."

B. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

C. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.

D. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
   1. Bulb Length: Minimum 20 feet.
   2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

E. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.
   1. Bulb Length: Minimum 20 feet.
   2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

F. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig, and cast housing with position indicator and adjusting knob.

2.05 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
   1. Comply with requirements in Division 22 and 23 Section "Motors."
   2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
   3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
   4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
   5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
   6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
   1. Manufacturers:
      a. Belimo Aircontrols (USA), Inc.
      b. Or equal by.
   2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
   3. Dampers: Size for running torque calculated as follows:
      a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
      b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
      c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
      d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
      e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
      f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
   4. Coupling: V-bolt and V-shaped16
   5. , toothed cradle.
   6. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
   7. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
   8. Power Requirements (Two-Position Spring Return): 24-V ac.
   9. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
   10. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
   11. Temperature Rating: 40 to 104 deg F.
   12. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.

13. Run Time: 30 seconds.

2.06 DAMPERS

A. Manufacturers:
   1. Air Balance Inc.
   2. Don Park Inc.; Autodamp Div.
   3. TAMCO (T. A. Morrison & Co. Inc.).
   4. United Enertech Corp.
   5. Vent Products Company, Inc.
   6. Ruskin.
   7. Pottorf.
   8. Or equal by.

B. Dampers: AMCA-rated, opposed-blade design; 0.108-inch- minimum thick, galvanized-steel or 0.125-inch- minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.
   1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze or nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
   2. Operating Temperature Range: From minus 40 to plus 200 deg F.
   3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
   4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.

2.07 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 26 Section "Voice and Data Communication Cabling."

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditioned power supply is available to control units and operator workstation.

3.02 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.
   1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

D. Install guards on thermostats in the following locations:
   1. Entrances.
   2. Public areas.
   3. Where indicated.

E. Install automatic dampers according to Division 22 and 23 Section "Duct Accessories."

F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

G. Install labels and nameplates to identify control components according to Division 22 and 23 Section "Mechanical Identification."

H. Install duct volume-control dampers according to Division 22 and 23 Sections specifying air ducts.

3.03 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceways and Boxes."

B. Install building wire and cable according to Division 26 Section "Conductors and Cables."

C. Install signal and communication cable according to Division 26 Section "Voice and Data Communication Cabling."
   1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
   2. Install exposed cable in raceway.
   3. Install concealed cable in raceway.
   4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
   5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
   6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
   7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
   2. Test and adjust controls and safeties.
   3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   4. Pressure test control air piping at 30 psig or 1.5 times the operating pressure for 24 hours, with maximum 5-psig loss.
   5. Pressure test high-pressure control air piping at 150 psig and low-pressure control air piping at 30 psig for 2 hours, with maximum 1-psig loss.
   6. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
   7. Test each point through its full operating range to verify that safety and operating control set points are as required.
   8. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
   9. Test each system for compliance with sequence of operation.
   10. Test software and hardware interlocks.

C. DDC Verification:
   1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
   2. Check instruments for proper location and accessibility.
   3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
   4. Check instrument tubing for proper fittings, slope, material, and support.
   5. Check installation of air supply for each instrument.
   6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
   7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
   8. Check temperature instruments and material and length of sensing elements.
   9. Check control valves. Verify that they are in correct direction.
   10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
   11. Check DDC system as follows:
      a. Verify that DDC controller power supply is from emergency power supply, if applicable.
      b. Verify that wires at control panels are tagged with their service designation and approved tagging system.

c. Verify that spare I/O capacity has been provided.
d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.05 ADJUSTING

A. Calibrating and Adjusting:
1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
a. Check analog inputs at 0, 50, and 100 percent of span.
b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
c. Check digital inputs using jumper wire.
d. Check digital outputs using ohmmeter to test for contact making or breaking.
e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
5. Flow:
a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
b. Manually operate flow switches to verify that they make or break contact.
6. Pressure:
a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
7. Temperature:
a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
b. Calibrate temperature switches to make or break contacts.
8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 1 Section "Demonstration and Training."

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SECTION 23 23 00

REFRIGERANT PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.03 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:
   1. Suction Lines for Air-Conditioning Applications: 300 psig.
   2. Suction Lines for Heat-Pump Applications: 535 psig.
   3. Hot-Gas and Liquid Lines: 535 psig.

1.04 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
   1. Thermostatic expansion valves.
   2. Solenoid valves.
   3. Hot-gas bypass valves.
   4. Filter dryers.
   5. Strainers.
   6. Pressure-regulating valves.

B. Welding certificates.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.05 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.06 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.07 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 PRODUCTS

2.01 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K or L.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:
   1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
   2. End Connections: Socket ends.
   3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
   4. Pressure Rating: Factory test at minimum 500 psig.
   5. Maximum Operating Temperature: 250 deg F.

2.02 VALVES AND SPECIALTIES

A. Service Valves:
   1. Body: Forged brass with brass cap including key end to remove core.
   2. Core: Removable ball-type check valve with stainless-steel spring.
   3. Seat: Polytetrafluoroethylene.
   4. End Connections: Copper spring.
   5. Working Pressure Rating: 500 psig.

B. Thermostatic Expansion Valves: Comply with ARI 750.
   1. Body, Bonnet, and Seal Cap: Forged brass or steel.
   2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
   3. Packing and Gaskets: Non-asbestos.
   4. Capillary and Bulb: Copper tubing filled with refrigerant charge.

5. Suction Temperature: 40 deg F.
6. Superheat: Adjustable.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 700 psig.

C. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

D. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

E. Moisture/Liquid Indicators:
1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

F. Replaceable-Core Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina or charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: See drawings.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

2.03 REFRIGERANTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Atofina Chemicals, Inc.
   2. DuPont Company; Fluorochemicals Div.
   3. Honeywell, Inc.; Genetron Refrigerants.
   4. INEOS Fluor Americas LLC.
   5. Prior approved equal.

B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 EXECUTION

3.01 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 3-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.

B. Hot-Gas and Liquid Lines: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with soldered joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with soldered joints.

3.02 VALVE AND SPECIALTY APPLICATIONS

A. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

B. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

C. Except as otherwise indicated, install diaphragm packless or packed-angle valves on inlet and outlet side of filter dryers.

D. Install a full-sized, three-valve bypass around filter dryers.

E. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

F. Install thermostatic expansion valves as close as possible to distributors on evaporators.
   1. Install valve so diaphragm case is warmer than bulb.
   2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
   3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

G. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

H. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

I. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
   1. Solenoid valves.
   2. Thermostatic expansion valves.
   3. Hot-gas bypass valves.
   4. Compressor.

J. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

K. Install receivers sized to accommodate pump-down charge.

L. Install flexible connectors at compressors.

3.03 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Division 22 and 23 Sections "HVAC Instrumentation and Controls" and "Sequence of Operation" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 8 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:
   1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
   2. Install horizontal suction lines with a uniform slope downward to compressor.
   3. Install traps and double risers to entrain oil in vertical runs.
   4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
   1. Shot blast the interior of piping.
   2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
   3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
   4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
   5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
   6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

R. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

S. Seal penetrations through fire and smoke barriers according to Division 7 Section "Through-Penetration Firestop Systems."

T. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

U. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

V. Seal pipe penetrations through exterior walls according to Division 7 Section "Joint Sealants" for materials and methods.

W. Identify refrigerant piping and valves according to Division 22 and 23 Section "Mechanical Identification."

3.04 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
   2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.05 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 22 and 23 Section "Hangers and Supports."

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
   2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
   4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
   8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.

3.06 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. Comply with ASME B31.5, Chapter VI.
   2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
   3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
      a. Fill system with nitrogen to the required test pressure.
      b. System shall maintain test pressure at the manifold gage throughout duration of test.
      c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
      d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.07 SYSTEM CHARGING

A. Charge system using the following procedures:
   1. Install core in filter dryers after leak test but before evacuation.
   2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
   3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
   4. Charge system with a new filter-dryer core in charging line.

3.08 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
   1. Open shutoff valves in condenser water circuit.
   2. Verify that compressor oil level is correct.
   3. Open compressor suction and discharge valves.
   4. Open refrigerant valves except bypass valves that are used for other purposes.
   5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

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SECTION 23 31 13

METAL DUCTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Single-wall rectangular ducts and fittings.
   2. Single-wall round and flat-oval ducts and fittings.
   3. Sheet metal materials.
   4. Duct liner.
   5. Sealants and gaskets.
   6. Hangers and supports.

B. Related Sections:
   1. Division 22 and 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
   2. Division 22 and 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing requirements for metal ducts.

1.03 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated.
   1. Static-Pressure Classes:
      a. Supply Ducts (except in Mechanical Rooms): 2-inch wg.
      b. Supply Ducts (Upstream from Air Terminal Units): 3-inch wg.
      c. Supply Ducts (Downstream from Air Terminal Units): 1-inch wg.
      d. Supply Ducts (in Mechanical Equipment Rooms): 2-inch wg.
      e. Return Ducts (Negative Pressure): 1-inch wg.
      f. Exhaust Ducts (Negative Pressure): 1-inch wg.
   2. Leakage Class:
      a. Round Supply-Air Duct: 3 cfm/100 sq. ft. at 1-inch wg.
      b. Flat-Oval Supply-Air Duct: 3 cfm/100 sq. ft. at 1-inch wg.
      c. Rectangular Supply-Air Duct: 6 cfm/100 sq. ft. at 1-inch wg.
      d. Flexible Supply-Air Duct: 6 cfm/100 sq. ft. at 1-inch wg.

B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
   1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
   2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
   3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

1.04 SUBMITTALS

A. Product Data: For each type of the following products:
   1. Liners and adhesives.
   2. Sealants and gaskets.
   3. Seismic-restraint devices.

B. Welding certificates.

C. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
   2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
   3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

PART 2 PRODUCTS

2.01 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.02 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Lindab Inc.
      b. McGill AirFlow LLC.
      c. SEMCO Incorporated.
      d. Sheet Metal Connectors, Inc.
      e. Spiral Manufacturing Co., Inc.
      f. Metco.
      g. Prior approved equal.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter (diameter of the round sides connecting the flat portions of the duct).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
   2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.03 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.04 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. CertainTeed Corporation; Insulation Group.
      b. Johns Manville.
      c. Knauf Insulation.
      d. Owens Corning.
      e. Prior approved equal.
      f. Maximum Thermal Conductivity:
         1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
         2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
   2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
   3. Solvent-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
   4. Duct insulation shall have a minimum R value = 5 for installation in an unconditioned space, and a minimum R value = 8 for installation outdoors.
   5.

B. Insulation Pins and Washers:
   1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."
   1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
   2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
   3. Butt transverse joints without gaps, and coat joint with adhesive.
   4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
   5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
   6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
   7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
   8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
      a. Fan discharges.
      b. Intervals of lined duct preceding unlined duct.
      c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
   9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
      a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
   10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.05 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Solids Content: Minimum 65 percent.
   3. Shore A Hardness: Minimum 20.
   4. Water resistant.
   5. Mold and mildew resistant.
   6. VOC: Maximum 75 g/L (less water).
   7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
   8. Service: Indoor or outdoor.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.
   1. General: Single-component, acid-curing, silicone, elastomeric.
   2. Type: S.
   3. Grade: NS.
   4. Class: 25.
   5. Use: O.

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:
   1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
   2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
   3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.06 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:
   1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
   2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
   3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 EXECUTION

3.01 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 22 Section "Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.02 SEAM AND JOINT SEALING

A. Seal duct seams and joints for duct static-pressure and leakage classes specified in "Performance Requirements" Article, according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements," unless otherwise indicated.
   1. For static-pressure classes 1- and 1/2-inch wg, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class C, except as follows:
      a. Ducts that are located directly in zones they serve.

3.03 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
   5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.04 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 22 and 23 Section "Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.05 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Duct system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.06 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

3.07 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel:

B. Intermediate Reinforcement:
   1. Galvanized-Steel Ducts: Galvanized steel.
   2. Stainless-Steel Ducts: Galvanized steel.
   3. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.

C. Liner:
   1. Supply- and Return-Air Ducts: Fibrous glass, Type I.

D. Double-Wall Duct Interstitial Insulation:
   1. Supply- and Return-Air Ducts: 1 inch thick.

E. Elbow Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
      a. Velocity 1000 fpm or Lower:
         1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
         2) Mitered Type RE 4 without vanes.
      b. Velocity 1000 to 1500 fpm:
         1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
         2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
         3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
      c. Velocity 1500 fpm or Higher:
         1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
         2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
         3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
    a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
        1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
        2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
        3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
    b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
    c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

F. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
    a. Rectangular Main to Rectangular Branch: 45-degree entry.
    b. Rectangular Main to Round Branch: Spin in.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
    a. Velocity 1000 fpm or Lower: 90-degree tap.
    b. Velocity 1000 to 1500 fpm: Conical tap.
    c. Velocity 1500 fpm or Higher: 45-degree lateral.

G. Duct Schedule
1. Rectangular duct with liner:
    a. Low pressure supply and return.
2. Rectangular duct wrapped with insulation:
    a. Low pressure exhaust and fresh air.
3. Single wall round with wrapped insulation.
    a. Low pressure supply and return.

END OF SECTION

SECTION 23 33 00

DUCT ACCESSORIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:
   1. Volume dampers.
   2. High Efficiency Take-Offs.
   3. Turning vanes.
   4. Flexible connectors.
   5. Flexible ducts.
   6. Duct accessory hardware.

B. Related Sections include the following:
   1. Division 22 and 23 Section "HVAC Instrumentation and Controls" for electric and damper actuators.

1.03 SUBMITTALS

A. Product Data: For the following:
   1. Volume dampers.
   2. High Efficiency Take-Offs.
   3. Turning vanes.
   4. Flexible connectors.
   5. Flexible ducts.

1.04 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.05 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards–Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G60 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.03 VOLUME DAMPERS

A. Manufacturers:
   1. Air Balance, Inc.
   2. American Warming and Ventilating.
   3. Clifco
   4. Flexmaster U.S.A., Inc.
   5. Leader
   6. McGill AirFlow Corporation.
   7. METALAIRE, Inc.
   8. Nailor Industries Inc.
   9. Penn Ventilation Company, Inc.
   10. Ruskin Company.
   11. Vent Products Company, Inc.
   12. Air Rite.
   13. Greenheck.
   14. Prior approved equal.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
   1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

C. Standard Volume Dampers: Opposed-blade design, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
   1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
   2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
   3. Aluminum Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
   4. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
   5. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
   6. Blade Axles: Galvanized steel.
   7. Bearings: Oil-impregnated bronze.
   8. Tie Bars and Brackets: Aluminum.
   9. Tie Bars and Brackets: Galvanized steel.

D. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.04 HIGH EFFICIENCY TAKE-OFF

A. Factory-manufactured rectangular-to-round or round-to-round 45 degree leading tap fabricated of 24 ga zinc-coated lockforming quality steel sheets meeting requirements of ASTM A 653, with G-90 coating.

B. One inch wide mounting flange with die formed corner clips, pre-punched mounting holes, and adhesive coated gasket.

C. Manual Volume Damper:
   1. Single blade, 22 ga minimum.
   2. 3/8 inch minimum square rod with brass damper bearings at each end.
   3. Heavy duty locking quadrant on 1-1/2 inch high stand-off mounting bracket attached to side of round duct.

D. Approved Manufacturers:
   1. HETD-L by Daniel Manufacturing.
   2. STO by Flexmaster USA Inc.
   3. HET by Sheet Metal Connectors Inc.
   4. Hercules.

5. Clifco
6. Air-Rite.
7. Prior approved equal.

2.05 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, single-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.
   1. Available Manufacturers:
      a. Ductmate Industries, Inc.
      b. Duro Dyne Corp.
      c. METALAIRE, Inc.
      d. Ward Industries, Inc.
      e. Prior approved equal.

C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.06 FLEXIBLE CONNECTORS

A. Manufacturers:
   1. Ductmate Industries, Inc.
   2. Duro Dyne Corp.
   3. Flex-Weld
   4. Ventfabrics, Inc.
   5. Ward Industries, Inc.
   6. Prior approved equal.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
   1. Minimum Weight: 26 oz./sq. yd..
   2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
   3. Service Temperature: Minus 40 to plus 200 deg F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
   1. Minimum Weight: 24 oz./sq. yd..

2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

2.07 FLEXIBLE DUCTS

A. Manufacturers:
   1. Flexmaster U.S.A., Inc.
   2. Hart & Cooley, Inc.
   3. McGill AirFlow Corporation.
   4. Themaflex.
   5. Quietflex
   6. Prior approved equal.

B. Insulated-Duct Connectors: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor barrier film.
   1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 20 to plus 210 deg F.

2.08 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 EXECUTION

3.01 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

F. Provide test holes at fan inlets and outlets and elsewhere as indicated.

G. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

H. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

I. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

J. Connect diffusers to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

K. Install duct test holes where indicated and required for testing and balancing purposes.

3.02 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 22 and 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION

SECTION 23 34 23

POWER VENTILATORS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Centrifugal roof ventilators.
   2. Centrifugal wall ventilators.
   3. Ceiling-mounted ventilators.
   4. In-line centrifugal fans.
   5. In-line corrosion resistant centrifugal fans.
   6. Propeller fans.

1.03 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Roof curbs.
   7. Fan speed controllers.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

C. Field quality-control reports.

D. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.06 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 PRODUCTS

2.01 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Manufacturing Corporation.
   2. Aerovent; a division of Twin City Fan Companies, Ltd.
   3. American Coolair Corporation.
   4. Breidert Air Products.
   5. Broan-NuTone LLC.
   6. Carnes Company.
   7. Greenheck Fan Corporation.
   8. JencoFan.
   9. Loren Cook Company.
   10. PennBarry.
   11. Prior approved equal

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
   1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
   2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt Drives:
   1. Resiliently mounted to housing.
   2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
   4. Pulleys: Cast-iron, adjustable-pitch motor pulley.
   5. Fan and motor isolated from exhaust airstream.

E. Accessories:
   1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
   2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
   3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
   4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
   1. Configuration: Built-in raised cant and mounting flange.
   2. Overall Height: 12 inches.
   3. Sound Curb: Curb with sound-absorbing insulation.
   4. Pitch Mounting: Manufacture curb for roof slope.
   5. Metal Liner: Galvanized steel.

G. Capacities and Characteristics: See drawings

2.02 CENTRIFUGAL WALL VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Manufacturing Corporation.
   2. Aerovent; a division of Twin City Fan Companies, Ltd.
   3. American Coolair Corporation.
   4. Breidert Air Products.
   5. Broan-NuTone LLC.
   6. Carnes Company.
   7. Greenheck Fan Corporation.
   8. JencoFan.
   9. Loren Cook Company.
   10. PennBarry.
   11. Prior approved equal

B. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; venturi inlet cone.

C. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.

D. Belt Drives:
   1. Resiliently mounted to housing.
   2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
   4. Pulleys: Cast-iron, adjustable-pitch motor pulley.
   5. Fan and motor isolated from exhaust airstream.

E. Accessories:
   1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through internal aluminum conduit.
   2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
   3. Wall Grille: Ring type for flush mounting.
   4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in wall sleeve; factory set to close when fan stops.
   5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

F. Capacities and Characteristics: See drawings

2.03 CEILING-MOUNTED VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Manufacturing Corporation.
   2. Aerovent; a division of Twin City Fan Companies, Ltd.
   3. American Coolair Corporation.
   4. Breidert Air Products.
   5. Broan-NuTone LLC.
   6. Carnes Company.
   7. Greenheck Fan Corporation.
   8. JencoFan.
   9. Loren Cook Company.
   10. PennBarry.
   11. Prior approved equal

B. Housing: Steel, lined with acoustical insulation.

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

D. Grille: Painted aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

F. Accessories:
   1. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
   2. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
   3. Motion Sensor: Motion detector with adjustable shutoff timer.
   4. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless-steel springs, and fusible link.
   5. Filter: Washable aluminum to fit between fan and grille.
   6. Isolation: Rubber-in-shear vibration isolators.
   7. Manufacturer's standard roof jack or wall cap, and transition fittings.

G. Capacities and Characteristics: See drawings

2.04 IN-LINE CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Manufacturing Corporation.
   2. Aerovent; a division of Twin City Fan Companies, Ltd.
   3. American Coolair Corporation.
   4. Breidert Air Products.
   5. Broan-NuTone LLC.
   6. Carnes Company.
   7. Greenheck Fan Corporation.
   8. JencoFan.
   9. Loren Cook Company.
   10. PennBarry.
   11. Prior approved equal

B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

F. Accessories:
   1. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
   2. Companion Flanges: For inlet and outlet duct connections.
   3. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
   4. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

G. Capacities and Characteristics: See drawings

2.05 IN-LINE CORROSION RESISTANT CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Plastec or equal by
   2. Acme Engineering & Manufacturing Corporation.
   3. Aerovent; a division of Twin City Fan Companies, Ltd.
   4. American Coolair Corporation.
   5. Breidert Air Products.
   6. Broan-NuTone LLC.
   7. Carnes Company.
   8. Greenheck Fan Corporation.
   9. JencoFan.
   10. Loren Cook Company.
   11. PennBarry.
   12. Strobic Aire
   13. Prior approved equal

B. Housing: Split, corrosion resistant non-ferrous with inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels: Corrosion resistant

F. Accessories:
   1. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
   2. Companion Flanges: For inlet and outlet duct connections.
   3. Fan Guards: 1/2- by 1-inch mesh in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
   4. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

G. Capacities and Characteristics: See drawings

2.06 PROPELLER FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Manufacturing Corporation.
   2. Aerovent; a division of Twin City Fan Companies, Ltd.
   3. American Coolair Corporation.
   4. Breidert Air Products.
   5. Broan-NuTone LLC.
   6. Carnes Company.
   7. Greenheck Fan Corporation.
   8. JencoFan.
   9. Loren Cook Company.
   10. PennBarry.
   11. Prior approved equal

B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.

D. Fan Wheel: Replaceable, cast-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

E. Fan Drive: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

F. Fan Drive:
   1. Resiliently mounted to housing.
   2. Statically and dynamically balanced.
   3. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
   4. Extend grease fitting to accessible location outside of unit.
   5. Service Factor Based on Fan Motor Size: 1.4.
   6. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   7. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
      a. Ball-Bearing Rating Life: ABMA 9, L10 of 100,000 hours.
   8. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
   9. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.

10. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
11. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

G. Accessories:
   1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
   2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
   3. Wall Sleeve: Galvanized steel to match fan and accessory size.
   4. Weathershield Hood: Galvanized steel to match fan and accessory size.
   5. Weathershield Front Guard: Galvanized steel with expanded metal screen.
   6. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

H. Capacities and Characteristics: See drawings

2.07 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 and 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

B. Enclosure Type: Totally enclosed, fan cooled.

2.08 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units using elastomeric mounts. Vibration- and seismic-control devices are specified in Division 22 and 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
   1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

C. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.

D. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

E. Support suspended units from structure using threaded steel rods and elastomeric hangers. Vibration-control devices are specified in Division 22 and 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

F. Install units with clearances for service and maintenance.

G. Label units according to requirements specified in Division 22 and 23 Section "Identification for HVAC Piping and Equipment."

3.02 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 22 and 23 Section "Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.03 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
   5. Adjust belt tension.
   6. Adjust damper linkages for proper damper operation.

7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.04 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Division 22 and 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION

SECTION 23 37 13

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes ceiling-diffusers and wall-mounted registers and grilles.

B. Related Sections include the following:
   1. Division 22 and 23 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.03 SUBMITTALS

A. Product Data: For each product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Products: Subject to compliance with requirements, provide one of the products specified.

2.02 GRILLES AND REGISTERS

A. Adjustable Bar Side Wall Supply Grille:
   1. Products:
      a. Carnes; RVEA.
      b. Krueger; 5815.
      c. METALAIRE, Inc., Metal Industries Inc.; 422.
      d. Price Industries; LBMR.
      e. Titus; 1707.
      f. Tuttle & Bailey; VF5.
      g. Or equal by:
         1) A-J Manufacturing Co., Inc.
         2) Anemostat; a Mestek Company.

3) Dayus Register & Grille.
4) Hart & Cooley, Inc.; Hart & Cooley Div.
5) Nailor Industries of Texas Inc.

2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Adjustable horizontal spaced 1/4 inch apart.
5. Frame: 1 inch wide.

B. Fixed Face Ceiling Return, Exhaust, or Transfer Air Grille:
1. Products:
a. Carnes; RSLA.
b. Krueger; S85H.
c. Price Industries; 535.
d. Titus; 355RL.
e. Tuttle & Bailey; T70D.
f. Or equal by:
1) A-J Manufacturing Co., Inc.
2) Anemostat; a Mestek Company.
3) Dayus Register & Grille.
4) Hart & Cooley, Inc.; Hart & Cooley Div.
5) Nailor Industries of Texas Inc.

2. Material: Steel.
3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2 inch horizontal blade spacing.
5. Frame: 1-1/4 inches wide.

2.03 CEILING DIFFUSER OUTLETS

A. Rectangular and Square Ceiling Diffusers:
1. Products:
a. Carnes.
b. Krueger.
c. METALAIRE, Inc., Metal Industries Inc.
d. Price Industries; SPD or equal by.
e. Titus.
f. Tuttle & Bailey.
g. A-J Manufacturing Co., Inc.
h. Anemostat; a Mestek Company.
i. Hart & Cooley, Inc.; Hart & Cooley Div.
j. Nailor Industries of Texas Inc.
k. Prior approved equal.

2. Material: Steel.
3. Finish: Baked enamel, white.

2.04 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, provide lay-in ceiling module. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.03 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

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SECTION 23 37 14

LOUVERS AND VENTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Fixed, extruded-aluminum louvers.

1.03 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades; i.e., the axes of the blades are horizontal.

C. Vertical Louver: Louver with vertical blades; i.e., the axes of the blades are vertical.

D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

E. Storm-Resistant Louver: Louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

1.04 PERFORMANCE REQUIREMENTS

A. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

1.05 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
   1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
   2. Show mullion profiles and locations.

3. Wiring Diagrams: For power, signal, and control wiring for motorized adjustable louvers.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of metal finish required.

E. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

1.06 QUALITY ASSURANCE

A. Source Limitations: Obtain louvers and vents from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

B. Welding: Qualify procedures and personnel according to the following:
1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
2. AWS D1.3, "Structural Welding Code - Sheet Steel."
3. AWS D1.6, "Structural Welding Code - Stainless Steel."

C. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

D. UL and NEMA Compliance: Provide motors and related components for motor-operated louvers that are listed and labeled by UL and comply with applicable NEMA standards.

1.07 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Aluminum Castings: ASTM B 26/B 26M, Alloy 319.

D. Fasteners: Use types and sizes to suit unit installation conditions.
1. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.
2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
3. For fastening galvanized steel, use hot-dip-galvanized steel or 300 series stainless-steel fasteners.

4. For fastening stainless steel, use 300 series stainless-steel fasteners.
5. For color-finished louvers, use fasteners with heads that match color of louvers.

E. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.02 FABRICATION, GENERAL

A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Include supports, anchorages, and accessories required for complete assembly.

C. Provide subsills made of same material as louvers or extended sills for recessed louvers.

2.03 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Nondrainable-Blade Louver:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ruskin Company; Tomkins PLC. Model ELF811 or equa by.
   b. Airolite Company, LLC (The).
   c. American Warming and Ventilating, Inc.; a Mestek company.
   d. Arrow United Industries; a division of Mestek, Inc.
   e. Carnes Company, Inc.
   f. Cesco Products; a division of Mestek, Inc.
   g. Greenheck Fan Corporation.
   h. NCA Manufacturing, Inc.
   i. Pottrof
   j. United Enertec
   k. Prior approved equal.
2. Fabrication: Continuous blade style.
   a. Frame:
      1) Frame Depth: 4 inches (102mm).
      2) Material: Extruded aluminum, Alloy 6063-T5.
      3) Wall Thickness: 0.125 inch (3.2mm), nominal.
   b. Blades:
      1) Style: Horizontal “K”.
      2) Material: Formed aluminum, Alloy 6063-T5.
      3) Wall Thickness: 0.125 inch (3.2 mm), nominal.

4) Angle: 45 degrees.
5) Centers: 4-1/2 inches (114 mm), nominal.
6) Continuous Blade Style – Design incorporates visible mullions or frames at the perimeter of the louver only. Rear-mounted hidden blade supports are utilized at section joints and at intermediate locations as needed. Louver blade sightlines are not interrupted at section joints or blade support locations. The rear-mounted blade support depth varies depending on louver height and the design windload.

c. Assembly:
1) Factory assembled louver components. Mechanically fastened construction.

B. Performance Data:
1. Performance Ratings:
a. Based on testing 48 inch by 48 inch (1219 mm by 1219 mm) size unit in accordance with AMCA 500.
2. Free Area: 44 percent, nominal.
3. Maximum Recommended Air Flow through Free Area: 707 feet per minute (214 m/min).
4. Air Flow: 5027 cubic feet per minute (142 cu. m/min).
5. Maximum Pressure Drop (Intake): .06 inches w.g. (14.9 Pa).
6. Water Penetration: Maximum of 0.01 ounces per square foot (3.1 g/sm) of free area at an air flow of 707 feet per minute (214 m/min) free area velocity when tested for 15 minutes.

C. Design Load: Incorporate structural supports required to withstand wind load of:
1. 20 lb/sf (0.96 kPa).
2. Per Code.
3. Louvers shall be factory engineered to withstand the specified seismic loads.
a. Minimum design loads shall be calculated to comply with ASCE – 7, or local requirements of Authority Having Jurisdiction.

2.04 ACCESSORIES

A. Aluminum Insulated Blank-Off Panels: 1 inch (25 mm), aluminum skin, insulated core, factory installed with removable screws and neoprene gaskets.

B. Hinged Frame: Continuous piano hinge attached to angle subframe.

C. Hinged Frame: Continuous piano hinge attached to channel subframe.

D. Bird Screen:
1. Aluminum: Aluminum, 3/4 inch by 0.051 inch (19 mm by 1.3 mm), expanded, flattened.
2. Aluminum: Aluminum, 5/8 inch by 0.040 inch (16 mm by 1 mm), expanded, flattened.
3. Aluminum: Aluminum, 1/2 inch mesh by 0.063 inch (13 mm mesh by 1.6 mm), intercrimp.

4. Steel: Galvanized steel, 1/2 inch mesh by 19 gage (13 mm mesh by 1.1 mm), intercrimp.
5. Frame: Removable, rewireable.

2.05 FINISHES

A. Kynar:
1. Coating shall conform to AAMA 2605. Apply coating following cleaning and pretreatment. Cleaning: AA-C12C42R1X.
2. Standard 2-coat.
3. Pearledize 70 (2-coat mica).

B. 50 percent Floropolymer-Based Painted Finishes:
1. Coating shall conform to AAMA 2604, sections 4.2 and 4.3. Apply coating following cleaning and pretreatment. Cleaning: AA-C12C42R1X.
2. Baked Enamel.
3. Pearledize 50 (2-coat mica).

C. Color for Kynar Finish:
1. Color: Custom. Refer to Drawings.

D. Anodized Finishes:
1. Class 2 Clear Anodized.
a. Comply with Aluminum Association AA-C22A41. Clear anodized finish 215-R1.
b. Apply finish following chemical etching and pretreatment.
c. Minimum Thickness: 0.7 mils (0.018 mm), 60 minute anodizing process.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.03 INSTALLATION

A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

F. Protect unpainted galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 7 Section "Joint Sealants" for sealants applied during louver installation.

3.04 ADJUSTING AND CLEANING

A. Test operation of adjustable louvers and adjust as needed to produce fully functioning units that comply with requirements.

B. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

D. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION

SECTION 23 54 00

FURNACES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:
   1. All electric furnaces and accessories complete with controls.
   2. Air filters.

1.03 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each of the following:
   1. Furnace.
   2. Air filter.
   3. Refrigeration components.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For each furnace to include in operation, and maintenance manuals for each of the following:
   1. Furnace and accessories complete with controls.
   2. Refrigeration components.

D. Warranty: Special warranty specified in this Section.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.05 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

1.06 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Disposable Air Filters: Furnish two complete sets.

PART 2 PRODUCTS

2.01 ALL ELECTRIC FURNACES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier Corporation; Div. of United Technologies Corp.
   2. Trane.
   3. York.
   4. Prior approved equal.

B. Cabinet: Steel.
   1. Cabinet interior around heat exchanger shall be factory-installed insulation.
   2. Lift-out panels shall expose burners and all other items requiring access for maintenance.
   3. Factory paint external cabinets in manufacturer's standard color.

C. Fan: Centrifugal, factory balanced, resilient mounted, direct drive.
   1. Fan Motors: Comply with requirements in Division 22 and 23 Section "Motors."
   2. Special Motor Features: Single speed, premium efficiency, as defined in Division 22 and 23 Section "Motors," and with internal thermal protection and permanent lubrication.
   3. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
   4. Special Motor Features: Electronically controlled motor (ECM) controlled by integrated furnace/blower control.

D. Furnace Controls: Solid-state board integrates electric heat, cooling, and fan speeds; and adjustable fan-on and fan-off timing; terminals for connection to accessories.

E. Capacities and Characteristics: See drawings.

2.02 AIR FILTERS

A. Disposable Filters: 1-inch- thick, disposable, fiberglass type in sheet metal frame.

2.03 REFRIGERATION COMPONENTS

A. Refrigerant Coil: Copper tubes mechanically expanded into aluminum fins. Comply with ARI 210/240, "Unitary Air-Conditioning and Air-Source Heat Pump Equipment." Match size with furnace. Include condensate drain pan with accessible drain outlet.
   1. Refrigerant Coil Enclosure: Steel, matching furnace and evaporator coil, with access panel and flanges for integral mounting at or on furnace cabinet and galvanized sheet metal drain pan coated with black asphaltic base paint.

B. Refrigerant Piping: Comply with requirements in Division 22 and 23 Section "Refrigerant Piping."

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine factory-installed insulation before furnace installation. Reject units that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install gas-fired furnaces and associated fuel and vent features and systems according to NFPA 54.

B. Suspended Units: Suspend from structure using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.
   1. Install seismic restraints to limit movement of furnace by resisting code-required seismic acceleration.

C. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions.
   1. Anchor furnace to substrate to resist code-required seismic acceleration.

D. Controls: Install thermostats and humidistats at mounting height of 60 inches above floor.

E. Wiring Method: Install control wiring in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal control wiring except in unfinished spaces.

3.03 CONNECTIONS

A. Gas piping installation requirements are specified in Division 22 and 23 Section "Fuel Gas Piping." Drawings indicate general arrangement of piping, fittings, and specialties. Connect gas piping with union or flange and appliance connector valve.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Vent Connection, Noncondensing, Gas-Fired Furnaces: Connect Type B vents to furnace vent connection and extend outdoors. Type B vents and their installation requirements are specified in Division 22 and 23 Section "Breechings, Chimneys, and Stacks."

D. Vent and Outside-Air Connection, Condensing, Gas-Fired Furnaces: Connect plastic piping vent material to furnace connections and extend outdoors. Terminate vent outdoors with a cap and in an arrangement that will protect against entry of birds, insects, and dirt.
   1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
   2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
   3. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
      a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
      b. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
      c. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
   4. Slope pipe vent back to furnace or to outside terminal.

E. Connect ducts to furnace with flexible connector. Comply with requirements in Division 22 and 23 Section "Duct Accessories."

F. Connect refrigerant piping to refrigerant coil in furnace and to air-cooled, compressor-condenser unit.
   1. Flared Joints: Use ASME B16.26 fitting and flared ends, following procedures in CDA's "Copper Tube Handbook."
   2. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
   3. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

G. Comply with requirements in Division 22 and 23 Section "Refrigerant Piping" for installation and joint construction of refrigerant piping.

3.04 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Perform electrical test and visual and mechanical inspection.
   2. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
   4. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
   5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

3.05 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   1. Inspect for physical damage to unit casings.
   2. Verify that access doors move freely and are weathertight.
   3. Clean units and inspect for construction debris.
   4. Verify that all bolts and screws are tight.
   5. Adjust vibration isolation and flexible connections.
   6. Verify that controls are connected and operational.

B. Adjust fan belts to proper alignment and tension.

C. Start unit according to manufacturer's written instructions and complete manufacturer's operational checklist.

D. Measure and record airflows.

E. Verify proper operation of capacity control device.

F. After startup and performance test, lubricate bearings.

3.06 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set controls, burner, and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features, including shutters, dampers, and relays, to provide optimum heating performance and system efficiency.

3.07 CLEANING

A. After completing installation, clean furnaces internally according to manufacturer's written instructions.

B. Install new filters in each furnace within 14 days after Substantial Completion.

3.08 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain condensing units. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION

SECTION 23 63 16

CONDENSING UNITS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes air-cooled condensing heat pump units.

1.03 SUBMITTALS

A. Product Data: For each condensing unit, include rated capacities, operating characteristics, furnished specialties, and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. Shop Drawings: Signed and sealed by a qualified professional engineer.
   1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
   2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
   3. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For condensing units to include in operation, and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

1.04 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of condensing units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Code for Mechanical Refrigeration."
   1. Units shall be designed to operate with HCFC-free refrigerants.

D. ASME Compliance: Fabricate and label water-cooled condensing units to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.05 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate location of piping and electrical rough-ins.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Compressor failure.
      b. Condenser coil leak.
   2. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 CONDENSING UNITS, AIR COOLED

A. Manufacturers:
   1. Carrier Corporation; Carrier Air Conditioning Div.
   2. Daikin
   3. Trane Co. (The); Worldwide Applied Systems Group.
   4. York International Corp.
   5. Prior approved equal

B. Description: Factory assembled and tested, consisting of compressor, condenser coil, fan, motors, refrigerant reservoir, and operating controls.

C. Compressor: Scroll, hermetically sealed, with rubber vibration isolators.
   1. Motor: Single speed, and includes thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   2. Two-Speed Compressor: Include manual-reset, high-pressure switch and automatic-reset, low-pressure switch.
   3. Accumulator: Suction tube.
   4. Reversing valve for heat pump operation

5. Refrigerant Charge: R-410A.

D. Condenser Coil: Seamless copper-tube, aluminum-fin coil; circuited for integral liquid subcooler, with removable drain pan and brass service valves with service ports.

E. Condenser Fan: Direct-drive, aluminum propeller fan; with permanently lubricated, totally enclosed fan motor with thermal-overload protection and ball bearings.

F. Accessories:
   1. Cycle Protector: Automatic-reset timer to prevent rapid compressor cycling.
   2. Electronic programmable thermostat to control condensing unit and evaporator fan.
   3. Evaporator Freeze Thermostat: Temperature-actuated switch that stops unit when evaporator reaches freezing temperature.
   4. Filter-dryer.
   5. High-Pressure Switch: Automatic-reset switch cycles compressor off on high refrigerant pressure.
   6. Liquid-line solenoid.
   7. Thermostatic expansion valve.
   8. Time-Delay Relay: Continues operation of evaporator fan after compressor shuts off.

G. Unit Casing: Galvanized steel, finished with baked enamel; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Mount service valves, fittings, and gage ports on exterior of casing.

2.03 MOTORS

A. General requirements for motors are specified in Division 22 and 23 Section "Motors."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

2.04 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate condensing units according to ARI 210/240.
   1. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
   2. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

B. Test and inspect shell and tube condensers according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of condensing units.

B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where condensing units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.

B. Install condensing units on concrete base. Concrete base is specified in Division 22 and 23 Section "Basic Mechanical Materials and Methods," and concrete materials and installation requirements are specified in Division 3.

C. Concrete Bases:
   1. Install dowel rods to connect concrete base to concrete slab. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of the base.
   2. For equipment supported on structural slab, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.
   5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

D. Install roof-mounting units on equipment supports specified in Division 7.

E. Vibration Isolation: Mount condensing units on rubber pads with a minimum deflection of 1/4 inch. Vibration isolation devices and installation requirements are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."

F. Vibration Isolation: Mount condensing units on restrained spring isolators with a minimum deflection of. Vibration isolation devices and installation requirements are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."

G. Maintain manufacturer's recommended clearances for service and maintenance.

H. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect refrigerant piping to air-cooled condensing units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Division 22 and 23 Section "Refrigerant Piping."

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

3.04 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Perform electrical test and visual and mechanical inspection.
   2. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   5. Verify proper airflow over coils.

B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

C. Remove and replace malfunctioning condensing units and retest as specified above.

3.05 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   1. Inspect for physical damage to unit casing.
   2. Verify that access doors move freely and are weathertight.
   3. Clean units and inspect for construction debris.
   4. Verify that all bolts and screws are tight.
   5. Adjust vibration isolation and flexible connections.
   6. Verify that controls are connected and operational.

B. Lubricate bearings on fans.

C. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.

D. Adjust fan belts to proper alignment and tension.

E. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.

F. Measure and record airflow over coils.

G. Verify proper operation of condenser capacity control device.

H. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

I. After startup and performance test, lubricate bearings.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain condensing units. Refer to Division 1 Section "Closeout Procedures and Demonstration and Training."

END OF SECTION

SECTION 23 74 13

PACKAGED ROOFTOP UNITS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes cooling and heating packaged rooftop units.

1.03 DEFINITIONS

A. DDC: Direct-digital controls.

1.04 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories.

B. Startup service reports.

C. Operation and Maintenance Data: For rooftop units to include in operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

1.05 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of rooftop units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Units shall be designed to operate with HCFC-free refrigerants.

1.06 COORDINATION

A. Coordinate size, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

B. Coordinate size, location, and installation of rooftop unit manufacturer's roof curbs and equipment supports with roof Installer.

1. Coordinate installation of restrained vibration isolation roof-curb rails, which are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."

1.07 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components listed below that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.

1.08 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fan Belts: One set for each belt-driven fan.
   2. Filters: One set for each unit.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AAON, Inc.
   2. Carrier.
   3. Daikin
   4. Trane.
   5. York
   6. Prior approved equal.

2.02 CABINET

A. Construction: Double wall.

B. Exterior Casing: with lifting lugs and knockouts for electrical and piping connections.

C. Interior Casing: Galvanized steel.

D. Base Rails: Galvanized-steel rails for mounting on roof curb.

E. Service Doors: Hinged access doors with neoprene gaskets.

F. Internal Insulation: Fibrous-glass duct lining complying with ASTM C 1071, Type II.
   1. Thickness: 1 inch.
   2. Insulation Adhesive: Comply with ASTM C 916, Type I.
   3. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.

G. Condensate Drain Pans: Formed sections of galvanized-steel sheet designed for self-drainage. Fabricate pans with slopes to preclude buildup of microbial slime.

H. Provide with auxiliary hail guards to protect the condenser fins from storm damage.

2.03 SUPPLY-AIR FAN

A. Fan: Forward-curved centrifugal; statically and dynamically balanced, galvanized steel, mounted on solid-steel shaft with self-aligning, permanently lubricated ball bearings.

B. Motor: Open dripproof,-speed motor.

C. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.4 service factor.

D. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with restrained, elastomeric isolators.

2.04 REFRIGERATION SYSTEM

A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

B. Compressors: Reciprocating or scroll heat pump compressors with integral vibration isolators, internal overcurrent and overtemperature protection, reversing valve, internal pressure relief, and crankcase heater.

C. EER and COP: as defined by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Refrigerant: R-410A.

E. Refrigeration System Specialties:
   1. Expansion valve with replaceable thermostatic element.
   2. Refrigerant dryer.
   3. High-pressure switch.
   4. Low-pressure switch.
   5. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
   6. Brass service valves installed in discharge and liquid lines.
   7. Operating charge of refrigerant.

F. Capacity Control: Hot-gas bypass refrigerant control for capacity control with continuous dehumidification on a single compressor.

G. Refrigerant Coils: Evaporator, condenser, and reheat condenser coils shall be designed, tested, fabricated, and rated according to ARI 410 and ASHRAE 33. Coils shall be leak tested under water with air at 315 psig.
   1. Capacity Reduction: Circuit coils for interleaved control.
   2. Tubes: Copper.

3. Fins: Aluminum.
4. Fin and Tube Joint: Mechanical bond.
5. Suction and Distributor: Seamless copper tube with brazed joints.
6. Source Quality Control: Test to 450 psig, and to 300 psig underwater.

H. Condenser Fan: Propeller type, directly driven by motor.

I. Safety Controls:
1. Compressor motor and outside-coil fan motor low ambient lockout.
2. Overcurrent protection for compressor motor and outside-coil fan motors.

2.05 ELECTRIC-RESISTANCE HEATING

A. Electric-Resistance Heating Elements: Coiled resistance wire of 80 percent nickel and 20 percent chromium; surrounded by compacted magnesium oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.

B. Electric-Resistance Heating Elements: Open-coil resistance wire of 80 percent nickel and 20 percent chromium; supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
1. Heating Capacity: Low density 35 W per sq. in., factory wired for single-point wiring connection; with time delay for element staging, and overcurrent and overheat protective devices.
2. Safety Controls:
a. Blower-motor interlock, air-pressure switch.
b. Quiet mercury contactors.
c. Time delay between steps.
d. Integral, nonfused power disconnect switch.

2.06 OUTDOOR-AIR INTAKE AND DAMPERS

A. Dampers: Leakage rate, according to AMCA 500, shall not exceed 2 percent of air quantity at face velocity of 2000 fpm through damper and pressure differential of 4-inch wg.

B. Damper Operators: Electric.

C. Mixing Boxes: Parallel-blade, galvanized-steel dampers mechanically fastened to steel operating rod inside cabinet. Connect operating rods with common interconnecting linkages so dampers operate simultaneously.

D. Outdoor-Air Intake Hoods: Galvanized steel, with bird screen and finish to match cabinet.

2.07 ECONOMIZER:

A. Provide fully modulating damper motors and controls to position outside and return air dampers so that outside air will be used to satisfy the building cooling load in the economizer cycle and minimum outside air during occupied mode.

B. Low leakage dampers shall ride on nylon bearings.

C. Integrated economizer control shall allow compressors to cycle for additional cooling as needed based on outdoor enthalpy.

D. Damper actuators shall be opposing gear driven, 24 volt, fully modulating design. Plug-in control board shall consist of adjustable minimum positioner, enthalpy setpoint, and DIP switches for setting type of control logic use.

E. Outdoor air hood with filters shall be galvanized steel with a powder coat enamel paint finish electrostatically bonded to the metal.

F. For units 5 tons and under, provide extruded aluminum gravity relief dampers to prevent blow-back and outdoor air infiltration during off cycle.

G. For units over 5 tons, provide Centrifugal power exhaust fan which ever is standard for size of unit.

H. Provide rainhoods and birdscreens.

2.08 FILTERS

A. Comply with NFPA 90A.

B. Cleanable Filters: 2-inch- thick, cleanable metal mesh.

C. Disposable Panel Filters: 2-inch- thick, factory-fabricated, flat-panel-type, disposable air filters with holding frames, with a minimum efficiency report value of 6 according to ASHRAE 52.2 and 90 percent average arrestance according to ASHRAE 52.1.
   1. Media: Interlaced glass fibers sprayed with nonflammable adhesive.
   2. Frame: Galvanized steel.

2.09 CONTROLS

A. Control equipment and sequence of operation are specified in Division 22 and 23 Section "HVAC Instrumentation and Controls."

B. Factory-wire connection for controls' power supply.

C. Control devices, including sensors, transmitters, relays, switches, thermostats, humidistats, detectors, operators, actuators, and valves, shall be manufacturer's standard items to accomplish indicated control functions.

D. Unit Controls: Solid-state control board and components with field-adjustable control parameters.

E. Supply-Fan Control: Units shall be electrically interlocked with corresponding exhaust fans, to operate continuously when exhaust fans are running. Time clock shall switch operation from occupied to unoccupied. Night setback thermostat shall cycle fan during unoccupied periods to maintain space temperature.
   1. Timer: Seven-day electronic clock.

2. Electrically interlock kitchen hood fire-extinguishing system to de-energize unit when fire-extinguishing system discharges.

F. Unit-Mounted Status Panel:
   1. Cooling/Off/Heating Controls: Control operational mode.
   2. Damper Position: Indicates position of outdoor-air dampers in terms of percentage of outdoor air.
   3. Status Lights:
      a. Filter dirty.
      b. Fan operating.
      c. Cooling operating.
      d. Heating operating.

G. Refrigeration System Controls:
   1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 28 Btu/lb of dry air or outdoor-air temperature is less than 60 deg F.
   2. Outdoor-air sensor de-energizes dehumidifier operation when outdoor-air temperature is less than 60 deg F.
   3. Wall-mounting, relative-humidity sensor energizes dehumidifier operation when relative humidity is more than 60 percent.

H. Heating Controls:

I. Electric-Resistance Heating Controls: Wall-mounting thermostat controls SCR.

J. Damper Controls:
   1. Wall-mounting pressure sensor modulates outdoor- and return-air dampers to maintain a positive pressure in space served by rooftop unit at minimum 0.05-inch wg.
   2. When exhaust fans stop, set outdoor- and return-air damper to 25 percent outdoor air. When exhaust fans start, close return-air damper and fully open outdoor-air damper.

K. Integral Smoke Alarm: Smoke detector installed in supply and return air.

2.10 MOTORS

A. Comply with requirements in Division 22 and 23 Section "Motors."

2.11 STANDARD ROOF CURB

A. Provide unit manufacturer's factory built curb that shall meet the National Roofing Contractors Association August 1985 guidelines for roof mounted installations.

B. The curb shall be 14 inches high, 16 gauge, galvanized steel construction with a 2 x 4 pressure treated wood nailer strip furnished on the outside.

C. Curb shall be installed by the roofing contractor.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation of rooftop units.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Examine roof curbs and equipment supports for suitable conditions where rooftop units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install roof curb on roof structure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." ARI Guideline B. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing with roof construction.

B. Install wall- and duct-mounting sensors, thermostats, and humidistats furnished by manufacturers for field installation. Install control wiring and make final connections to control devices and unit control panel.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Duct Connections: Duct installation requirements are specified in Division 22 and 23 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to rooftop units with flexible duct connectors. Flexible duct connectors are specified in Division 22 and 23 Section "Duct Accessories."

C. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

3.04 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   1. Inspect for visible damage to compressor, air-cooled outside coil, and fans.
   2. Inspect casing insulation for integrity, moisture content, and adhesion.
   3. Verify that clearances have been provided for servicing.

4. Verify that controls are connected and operable.
5. Verify that filters are installed.
6. Clean outside coil and inspect for construction debris.
7. Clean furnace flue and inspect for construction debris.
8. Inspect and adjust vibration isolators and seismic restraints.
9. Verify bearing lubrication.
10. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
11. Adjust fan belts to proper alignment and tension.
12. Start unit.
13. Start refrigeration system when outdoor-air temperature is within normal operating limits.
14. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
15. Operate unit for run-in period.
16. Calibrate thermostats.
17. Adjust and inspect high-temperature limits.
18. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
19. Start refrigeration system and measure and record the following:
    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outdoor-air, dry-bulb temperature.
    d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
20. Verify operational sequence of controls.
21. Measure and record the following airflows. Plot fan volumes on fan curve.
    a. Supply-air volume.
    b. Return-air volume.
    c. Outdoor-air intake volume.
22. Simulate maximum cooling demand and inspect the following:
    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through outside coil or from outside coil to outdoor-air intake.
23. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
    a. High-limit heat exchanger.
    b. Alarms.

C. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.

D. Remove and replace components that do not pass tests and inspections and retest as specified above.

E. Prepare written report of the results of startup services.

3.05 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain rooftop units. Refer to Division 1 Section "Closeout Procedures and Demonstration and Training."

END OF SECTION

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SECTION 23 82 37

ELECTRIC UNIT HEATERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Cabinet unit heaters with centrifugal fans and electric-resistance heating coils.
   2. Propeller unit heaters with electric-resistance heating coils.
   3. Wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.03 DEFINITIONS

A. BAS: Building automation system.

B. CWP: Cold working pressure.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.04 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Plans, elevations, sections, and details.
   2. Location and size of each field connection.
   3. Details of anchorages and attachments to structure and to supported equipment.
   4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
   5. Location and arrangement of piping valves and specialties.
   6. Location and arrangement of integral controls.
   7. Wiring Diagrams: Power, signal, and control wiring.

C. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.

D. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.06 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Cabinet Unit Heater Filters: Furnish one spare filter(s) for each filter installed.

PART 2 PRODUCTS

2.01 CABINET UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Airtherm; a Mestek Company.
   2. Berko Electric Heating; a division of Marley Engineered Products.
   3. Carrier Corporation.
   4. Chromalox, Inc.; a division of Emerson Electric Company.
   5. Dunham-Bush, Inc.
   6. Engineered Air Ltd.
   7. Indeeco.
   8. International Environmental Corporation.
   9. Markel Products; a division of TPI Corporation.
   10. Marley Electric Heating; a division of Marley Engineered Products.
   11. McQuay International.
   12. Ouellet Canada Inc.
   13. QMark Electric Heating; a division of Marley Engineered Products.
   14. Rosemex Products.
   15. Trane.
   16. USA Coil & Air.
   17. Prior approved equal.

B. Description: Class 1 Division 2 explosion proof spark resistant construction factory-assembled and -tested unit complying with ARI 440.
   1. Comply with UL 2021.
   2. Thickness: 1 inch.
   3. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
   4. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
   5. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.

C. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.
   1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch- thick, galvanized, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
   2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch- thick, galvanized, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
   3. Recessing Flanges: Steel, finished to match cabinet.
   4. Control Access Door: Key operated.
   5. Base: Minimum 0.0528-inch- thick steel, finished to match cabinet, 4 inches high with leveling bolts.
   6. Extended Piping Compartment: 8-inch- wide piping end pocket.
   7. False Back: Minimum 0.0428-inch- thick steel, finished to match cabinet.
   8. Outdoor-Air Wall Box: Minimum 0.1265-inch- thick, aluminum, rain-resistant louver and box with integral eliminators and bird screen. Aluminum louver with baked-enamel finish in color selected by Architect from manufacturer's standard colors.
      a. Outdoor-Air Damper: Galvanized-steel blades with edge and end seals and nylon bearings; with electronic, two-position actuators.

D. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   1. Washable Foam: 70 percent arrestance and 3 MERV.

E. Fan and Motor Board: Removable.
   1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
   2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 22 and 23 Section "Common Motor Requirements for HVAC Equipment."
   3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

F. Basic Unit Controls:
   1. Control voltage transformer.
   2. Wall-mounting thermostat with the following features.
      a. Heat-off switch.
      b. Fan on-auto switch.
      c. Manual fan speed switch.
      d. Adjustable deadband.
      e. Exposed set point.
      f. Exposed indication.
      g. Deg F indication.
   3. Wall-mounting temperature sensor.
   4. Unoccupied period override push button.

5. Data entry and access port.
    a. Input data includes room temperature, and occupied and unoccupied periods.
    b. Output data includes room temperature, supply-air temperature, entering-water temperature, operating mode, and status.

G. Electrical Connection: Factory wire motors and controls for a single field connection.

H. Capacities and Characteristics: See drawings.

2.02 PROPELLER UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    1. Airtherm; a Mestek Company.
    2. Engineered Air Ltd.
    3. McQuay International.
    4. Rosemex Products.
    5. Ruffneck Heaters; a division of Lexa Corporation.
    6. Trane.
    7. Prior approved equal.

B. Description: Class 1 Division 2 explosion proof spark resistant construction assembly including casing, coil, fan, and motor in vertical and horizontal discharge configuration with adjustable discharge louvers.

C. Comply with UL 2021.

D. Comply with UL 823.

E. Cabinet: Removable panels for maintenance access to controls.

F. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.

G. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

H. Electric-Resistance Heating Elements: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.
    1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
    2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

I. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

J. Fan Motors: Comply with requirements in Division 22 and 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Motor Type: Permanently lubricated, explosion proof.

K. Control Devices:
   1. Wall-mounting, fan-speed switch.
   2. Wall-mounting thermostat.

L. Capacities and Characteristics: See drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before unit heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Division 7 Section "Joint Sealants."

B. Install cabinet unit heaters to comply with NFPA 90A.

C. Install propeller unit heaters level and plumb.

D. Suspend cabinet unit heaters from structure with elastomeric hangers and seismic restraints. Vibration isolators and seismic restraints are specified in Division 22 and 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

E. Suspend propeller unit heaters from structure with all-thread hanger rods and spring hangers with vertical-limit stop. Hanger rods and attachments to structure are specified in Division 22 and 23 Section "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Division 22 and 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

F. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

G. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.03 CONNECTIONS

A. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Division 22 and 23 Section "Duct Accessories."

B. Comply with safety requirements in UL 1995.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect**, test, and adjust** field-assembled components and equipment installation, including connections**, and to assist in field testing**. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
   3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.05 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section specifies general requirements for electrical work for the Lake Powell Intake Pump Station (Intake PS), the LeChee Water Treatment Plant (WTP), and the LeChee Pump Station (PS) No. 3. Detailed requirements for specific electrical items are specified in other sections but are subject to the general requirements of this section. The electrical drawings and schedules included in this project manual are functional in nature and do not specify exact locations of equipment or equipment terminations.
2. Intake PS.
    a. The existing PS has been abandoned and turned over from the previous owner to the Owner.
    b. Demolish from the existing pump building:
        1) Power and control circuits for two existing 4,160 Volt powered pump trains, each consisting of two pumps. Two pumps are located in the building, two pumps are located outside in vaults.
        2) Lighting for pump trains below.
        3) Power and control circuits for existing Quagga Mussel pre-treatment system.
        4) Power circuits for existing outdoor crane.
        5) Power circuits for existing oil water separator pumps and heat trace.
        6) Remove power and control circuits for the above back to existing sources.
        7) Any other existing building power and control infrastructure shall be abandoned in place.
        8) Removed equipment: Coordinate with NTUA.
    c. Provide power and control infrastructure, building/enclosure, equipment, and telemetry for two pump trains. Provide space in the control building for two future VFDs for a future third pump train, but no power or control infrastructure.
    d. Replace and provide replacement power circuits for lighting for two pump trains in the existing pump building.
    e. Provide replacement power circuit for the existing outdoor crane.
    f. Provide replacement power and control circuits and Quagga Mussel pre-treatment system.
    g. Provide power circuits for the existing oil water separator pumps and heat trace.
    h. Test and verify operation of Intake PS to provide raw water to the WTP below.
    i. Test and verify telemetry of control and SCADA signals to/from Intake PS and WTP via the LeChee PS No. 3, refer to Volume 2 Drawing I-00-301.

3. Provide WTP.
    a. Provide treatment plant, equipment, and telemetry.
    b. Test and verify operation of WTP to to provide treated water to the PS below.
    c. Test and verify telemetry of control and SCADA signals to/from Intake PS and WTP via the LeChee PS No. 3, refer to Volume 2 Drawing I-00-301.
4. LeChee PS No. 3 to provide water to the existing LeChee Tanks below.
    a. Provide equipment and telemetry.
    b. Test and verify operation of PS to control existing LeChee Tanks level below.
    c. Provide fiber optic cable from PS to intercept existing cable per Section 27 13 23.23.
    d. Provide SCADA and test.
5. LeChee Tanks exist. This site shall communicate with LeChee Pump Station No. 3 via radio telemetry.
    a. Provide modifications to the existing telemetry.
    b. Test telemetry to LeChee PS No. 3.
    c. Schedule and coordinate work to minimize water system control outages. Refer to Sections 01 11 00 and 01 12 16.
6. Provide separate submittals and O&Ms for equipment for each of the Intake PS, WTP, and LeChee PS No. 3.
7. Work is further specified in Section 40 61 13.
8. Provide work as specified and per NTUA Standard Drawings and Indian Health Services – Navajo Nation – Standard Drawings.
9. Provide testing per Sections 01 45 20, 26 08 00, and 40 61 21.
10. Provide arc flash hazard analysis, setting of overcurrent protection, and hazard labeling for each of the Intake PS, WTP, and LeChee PS No. 3 per Section 26 05 74.
11. Programming shall be provided as specified in Section 40 61 13, coordinate work, programmers, and provide testing.

B. Definitions:
1. Elementary or Schematic Diagram:
    a. A schematic (elementary) diagram shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. The schematic diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.
2. One-Line Diagram:
    a. A one-line diagram shows by means of single lines and graphical symbols the course of an electrical circuit or system of circuits and the components, devices or parts used therein. Physical relationships are usually disregarded.
3. Block Diagram:
    a. A block diagram is a diagram of a system, instrument, computer, or program in which selected portions are represented by annotated boxes and interconnecting lines.

4. Arrangement, Layout, Or Outline Drawings:
    a. An arrangement, layout, or outline drawing is one which shows the physical space and mounting requirements of a piece of equipment. It may also indicate ventilation requirements and space provided for connections or the location to which connections are to be made.

1.02 QUALITY ASSURANCE

A. References:
1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NECA-1	National Electrical Contractors Association – Standard Practices for Good Workmanship in Electrical Contracting
NFPA	National Fire Protection Association
NFPA-70	National Electrical Code (NEC)
NFPA-70E	Standard for Electrical Safety in the Workplace
ANSI C2	National Electrical Safety Code (NESC)
ACI 318	Building Code Requirements for Structural Concrete
	Navajo Area Indian Health Service/NTUA – Technical Provisions 4.0 for Tank Control Panel

B. Identification of Listed Products:
1. List electrical equipment and materials for the purpose for which they are to be used, by an independent testing laboratory. Three such organizations are Underwriters Laboratories (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). Independent testing laboratory shall be acceptable to the inspection authority having jurisdiction.
2. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority, to undergo inspection at the manufacturer's place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

C. Power Utility:
1. The power utility is Navajo Tribal Utility Authority (NTUA), (928) 729-5721.

2. Provide installations per their requirements.

1.03 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00. Each specification will identify any additional requirements beyond those identified in 01 33 00.

B. Where specified, separate submittals shall be provided for each of the Intake PS, LeChee WTP, and LeChee PS No. 3. In the event that combined submittals are permitted, information shall be separated by each facilty. Failure to separate product literature by facility shall be sufficient cause for rejection of the entire submittal with no further consideration.

C. Informational Submittals:
   1. Record drawings per paragraph 3.03..

1.04 PROJECT/SITE CONDITIONS

A. General: Unless otherwise specified, size and derate equipment and materials for the ambient conditions specified in Section 01 11 80, but not less than an ambient temperature of 40 degrees C at an of approximately 4,323 feet without exceeding the manufacturer's stated tolerances.

B. Corrosive Areas:
   1. WTP Treatment Process Room.

C. Hazardous (Classified) Areas:
   1. None.

D. Enclosure Material and Rating
   1. Table A specifies the electrical enclosure material and rating for the location and application.

TABLE A

Location	Electrical Enclosure Material and NEMA Rating
Indoor: Architecturally Finished Area	NEMA 12: Mild steel
Indoor: Electrical Room	NEMA 12: Mild steel
Indoor: Process or Corrosive Areas	NEMA 4X: Stainless Steel
Outdoor: Non-Corrosive Areas	NEMA 3R or 4: Mild steel
Corrosive Area (Hypochlorite)	NEMA 4X: Non-metallic

E. Support Material and Rating
   1. Table B specifies the support material for mounting and supporting equipment and rating for the location and application.

Table B

Location	Framing Channel	Threaded Rod, Hardware, & Fittings
Indoor, Architecturally finished Area	Steel, HDG	Steel, HDG
Indoor, Electrical Room	Steel, HDG	Steel, HDG
Indoor, Process and Corrosive Areas	Stainless Steel or PVC	Stainless Steel, PVC
Corrosive Area (hypochlorite area)	Fiberglass or PVC	316 Stainless Steel, PVC
Outdoor Areas, Non-corrosive	HDG	Steel, HDG

HDG = Hot Dip Galvanized Finish

PVC = PVC Coated

F. Seismic:
   1. Design and install electrical equipment, supports, and anchorage in accordance with the seismic design requirements specified in Section 01 73 24 and Drawing S-00-001.

1.05 STORAGE OF MATERIALS AND EQUIPMENT

A. Store materials and equipment as specified in Section 01 66 00. Seal indoor designated equipment and materials with plastic wrap and store.

PART 2 PRODUCTS

2.01 EQUIPMENT AND MATERIALS

A. General:
   1. Provide equipment and materials new and free from defects. Provide all material and equipment of the same or a similar type from the same manufacturer throughout the work. Use standard production materials wherever possible.

B. Equipment Finish:
   1. Unless otherwise specified, Manufacturer shall paint electrical equipment per Manufacturer standards.

2.02 NAMEPLATES

A. Nameplates shall be made from laminated phenolic plastic.
   1. Nominal size: 3/4 inch high by 2 inches long.
   2. Black backgrounds with 3/16-inch white letters.
   3. Fastened using self-tapping stainless steel screws. Nameplate adhesives will not be permitted on the outside of enclosures.
   4. Abbreviations required because of space limitations shall be submitted to the Construction Manager prior to manufacture.
   5. Provide nameplate for each electrical equipment item engraved as follows: (EQUIPMENT NUMBER, IF ANY) / (EQUIPMENT NAME) / (VOLTAGE) VOLTS.

PART 3 EXECUTION

3.01 GENERAL

A. Construction:

1. The work under Division 26 shall be performed in accordance with these specifications.
2. Refer to the National Electrical Contractors Association's (NECA) National Electrical Installation Standards (NEIS) for Standard Practices for Good Workmanship in Electrical Contracting (NECA-1) as a minimum baseline of quality and workmanship for installing electrical products and systems that defines what is meant by "neat and workmanlike" as required by the National Electrical Code Section 110-12. Specified requirements supersede NECA practices.
3. Electrical layout drawings are diagrammatic, unless otherwise detailed or dimensioned. The Contractor shall coordinate the location of electrical material or equipment with the work.
4. Major electrical openings may compromise the structural integrity of the slab and wall elements. Major electrical openings are defined as openings or penetrations greater than two times the wall thickness in any dimension, and include duct bank transitions into a building through structural elements. Major electrical openings shall be constructed according to standard details on the drawings, up to an opening dimension of three feet. For opening dimensions greater than three feet, construct walls and slabs as specifically detailed on the drawings for that case. Major electrical openings proposed by the Contractor shall be submitted to the Structural Engineer for the project for review.
5. Minor changes in location of electrical material or equipment made prior to installation shall be made at no cost to the Owner.

B. Housekeeping:

1. Protect electrical equipment from dust, water and damage. Wipe motor control centers, switchgear, and buses free of dust and dirt, keep dry, and vacuum on the inside within 30 days of acceptance of the work.
2. Before final acceptance, the touch up any scratches on equipment as specified in Section 09 90 00-3.03.
3. Protect electrical equipment temporarily exposed to weather, debris, liquids, or damage during construction as specified in Section 01 66 00-2.06.

C. Electrical Equipment Labeling:

1. Provide electrical equipment with field marked signs and labeling to warn qualified persons of the potential electric arc flash hazards per NEC Article 110.16 Flash Protection.
2. Provide electrical equipment with NFPA 70E labels installed stating the results of the Arc Flash analysis specified in Section 26 05 74 Short Circuit and Protective Device Coordination Study Report.
3. Provide electrical distribution equipment and utilization equipment with field labels to identify the power source and the load as specified. Refer to NEC Article 110.22 for Identification of Disconnecting Means installation criteria. Specific information is required such as the equipment tag number and equipment description of both the power source and the load equipment.

D. Motor Connections
    1. Verify that the motors are purchased with the correct size motor termination boxes for the circuit content specified as shown on the power single line diagrams or submit custom fabrication drawing indicating proposed motor termination box material, size, gasket, termination kit, grounding terminal, motor lead connection method, and motor terminal box connection/support system. Verify the motor termination box location prior to raceway rough-in.

3.02 TESTING

A. General:
    1. Provide testing in accordance with Section 26 08 00

3.03 RECORD DOCUMENTS

A. Contract Documents:
    1. Maintain and annotate contract documents during construction, including the record drawings specified in Section 01 78 39.

END OF SECTION

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SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies stranded copper cables, conductors, and wire rated 600 volts insulation used for power; lighting, analog, digital, or pulse signals and control circuits.

B. This section specifies shielded multiconductor cable from VFD to motor for use at the Intake PS and LeChee WTP.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to document shall mean the documents in effect at the time of Advertisement for bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM B3	Soft or Annealed Copper Wire
ASTM B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Tinned Soft or Annealed Copper Wire for Electrical Purposes
ICEA S-68-516	Ethylene-Propylene-Rubber-Insulated Wire
NEMA WC7	Cross-Linked-Thermosetting Insulated Wire and Cable for the Transmission and Distribution of Electric Energy
NFPA 70	National Electric Code (NEC)
UL 44	Rubber-Insulated Wires and Cables
UL 83	Thermoplastic-Insulated Wires and Cables

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00 and 26 05 00.

B. Provide separate submittals for each of the Intake PS, LeChee WTP, and LeChee PS No. 3 for the following:

C. Action Submittals – Shop Drawings and Product Literature:

1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. Complete catalog cuts for all conductors, wire, and cable.

PART 2 PRODUCTS

2.01 GENERAL

A. Unscheduled Conductors and Cables:

1. Where not specified on the Drawings, conductors and cables shall be sized in accordance with the National Electrical Code for the particular equipment served with the minimum size as specified herein. Unscheduled conductor with insulation shall be provided in accordance with the following:
   a. CABLESPEC "MEPR/XLP" multi-conductor power and control cable.
   b. CABLESPEC “XHHW-2” for single conductors.
   c. CABLESPEC THWN-2 for indoor lighting and receptacles.

B. Cable Specification Sheets (CABLESPEC):

1. General requirements for conductors and cables specified in this Section are listed on CABLESPEC sheets in paragraph 3.06.

2.02 COLOR CODING

A. Control Conductors:

1. Single-conductor control conductors shall have the following colors for the indicated voltage:

Control Conductor	Color
Power (AC)	Black
Control (AC)	Red
Neutral	White
Ground	Green
Power (24V DC)	Violet
Control (24V DC)	Blue
Analog Signal (+)	White

Control Conductor	Color
Analog Signal (-)	Black

B. Power Conductors:
   1. Power conductors shall have the following colors for the indicated voltage:

Power Conductor	480V	208/120V
Phase A	Brown	Black
Phase B	Orange	Red
Phase C	Yellow	Blue
Ground	Green	Green
Neutral	Gray	White

C. Cables may be black with colored 3/4-inch vinyl plastic tape applied at each cable termination and in pull boxes, handholes and manholes. Tape shall be wrapped with 25 percent overlay to provide 3 inches minimum coverage.

D. Signal Conductors:
   1. Signal cable conductors shall be color coded black and white for pairs or black, white, and red for triads. Each conductor and each group of conductors shall be numbered.

2.03 POWER AND CONTROL CONDUCTORS AND CABLE, 600 VOLT

A. Single Conductor:
   1. Provide stranded conductors for all cable or wires. Provide minimum conductor size of 12 American Wire Gauge (AWG) for power and lighting circuits and minimum conductor size of 14 AWG for control circuits.

B. Multiconductor Cable:
   1. Provide multiconductor power cable and multiconductor control cable where identified on the drawings. Provide stranded conductors for all cable or wires.

2.04 SIGNAL CABLES

A. General:
   1. Factory cable between manufactured instrument system components shall be provided in compliance with the instrument manufacturer's recommendations.
   2. Signal cable shall be provided for instrument signal transmission. Single instrument cable (SIC) and multiple-circuit instrument cable (MIC) shall be provided in accordance with the following examples:
      a. CABLESPEC “SIC”:
         1) Cable designation:
            a) 1PR#18S shielded twisted pair (STP)
         2) Cable designation:
            a) 1TR#18S triad (STT)

b. CABLESPEC “MIC":
   1) Cable designation example:
      a) 4PR#18S with individual shields for each of the four pair and an overall shield and jacket for the multiconductor instrument cable.

2.05 PORTABLE CORD

A. Portable cord shall be provided in accordance with CABLESPEC "CORD," unless otherwise specified. Cords shall contain an equipment grounding conductor.

2.06 SPLICING AND TERMINATING MATERIALS

A. Connectors shall be tool applied compression type of correct size and Underwriter Laboratories (UL) listed for the specific application. Connectors shall be tin-plated high conductivity copper. Wire nuts for a splice is prohibited.

B. Signal and control conductors shall be connected to terminal blocks and field devices and instruments shall be terminated with conductor terminals as specified in Paragraph 2.10.

C. Connectors for wire sizes No. 8 AWG and larger shall be compression tool installed one-hole lugs up to size No. 3/0 AWG, and two-hole or four-hole lugs for size No. 4/0 and larger. Mechanical clamp, dimple, screw-type connectors are not acceptable. In-line splices and taps shall be used only by written consent of the Construction Manager.

D. Power conductor splices shall be compression type, made with a compression tool die approved for the purpose, as made by Thomas and Betts Corp., or equal. Splices shall be covered with electrical products designed for the application, insulated, and covered with a heat-shrinkable sleeve or boot, as specified elsewhere.

E. Motor connection kits shall consist of heat-shrinkable, polymeric insulating material over the connection area and high dielectric strength mastic to seal the ends against ingress of moisture and contamination. Motor connections may use the Tyco Electronics removable boot product line.

F. Motor connection kits shall accommodate a range of cable sizes for both in-line and stub-type configurations. Connection kits shall be independent of cable manufacturer's tolerances. Refer to the electric motor specification Section 43 05 21.

2.07 NOT USED

2.08 CONDUCTOR NUMBERING

A. Conductor Numbers:
   1. Identify conductors with numbers at both ends. Conductor tag numbers are the equipment number followed by a dash followed by the conductor number specified on the control diagram. Example:
      a. Equipment Tag number = 1900 - L1 where:
      b. 1900 = cable number
      c. L1 = conductor number

2. Conductors in parallel or in series between equipment have the same conductor number. Neutral conductors s have the same conductor number. Wherever possible, the conductor number is the same as the equipment terminal to which it connects.
3. Where factory-wired equipment has terminal numbers different than the conductor numbers shown on the control diagrams:
    a. Show both on the interconnection diagram
    b. Include a copy of the interconnection diagram inside of the equipment cabinet.

2.09 WIRE MARKERS

A. Identify each power and control conductor at each terminal to which it is connected. Provide identification sleeves for conductors size No. 10 AWG or smaller. Use locking tab type cable markers for conductors No. 8 AWG and larger. Provide white plastic tabs with conductor identification number permanently embossed.

B. Identify conductors in accordance with paragraph 2.08 Conductor Numbering. Adhesive strips are not acceptable.

C. Machine print the letters and numbers that identify each wire on sleeves with permanent black ink with figures 1/8 inch high. Provide yellow or white tubing for sleeves sized to fit the conductor insulation. Shrink the sleeves with hot air after installation to fit the conductor.

2.10 TERMINAL BLOCKS

A. Unless otherwise specified, terminal blocks shall be panhead strap screw type. Terminals shall be provided with integral marking strips that permanently identify with the connecting wire numbers as shown on the drawings:
    1. Terminal blocks for P-circuits (power 208-600 volts)
        a. Rated not less than the conductor current rating
        b. Rated less than 600 volts AC.
    2. Terminal blocks for C-circuits and S-circuits:
        a. Rated not less than 20 amperes
        b. Rated less than 600 volts AC.
    3. Terminals shall be tin-plated.
    4. Insulating material shall be nylon.

PART 3 EXECUTION

3.01 GENERAL

A. Conductors shall be identified at each connection terminal, in pull boxes, handholes, and at splice points. The identification marking system shall comply with Section 26 05 00.

B. Pulling wire and cable into conduit or trays shall be completed without damaging or putting undue stress on the insulation or jacket. Manufacture recommended and UL Listed pulling compounds are acceptable lubricants for pulling wire and cable. Grease is not acceptable.

C. Raceway construction shall be complete, cleaned, and protected from the weather before cable is installed. Where wire or cable exits a raceway, a wire or cable support shall be provided.

D. Provide tin-plated bus bar. Scratch-brush the contact areas and tin plate the connection where flat bus bar connections are made with un-plated bar. Bolts shall be torqued to the bus manufacturer's recommendations.

3.02 600 VOLT CONDUCTOR AND CABLE

A. Conductors in panels and electrical equipment shall be bundled and laced at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Lacing shall be made up with plastic cable ties. Cable ties shall be tensioned and cut off by using a tool specifically designed for the purpose such as a Panduit GS2B. Other methods of cutting cable ties are unacceptable.

B. Conductors crossing hinges shall be bundled into groups not exceeding 10 to 15 conductors and protected using nylon spiral flexible covers to protect conductors. Provide oversized plastic panel wiring duct within panels and panelboards.

C. Slack shall be provided in junction and pull boxes and handholes. Slack shall be sufficient to allow cables or conductors to be routed along the walls. Amount of slack shall be equal to largest dimension of the enclosure.

D. Raceway fill limitations shall be as defined by NEC and the following:
   1. Lighting and receptacle circuits may be in the same conduit in accordance with de-rating requirements of the NEC. Lighting and receptacle circuits shall not be in conduits with power or control conductors. Signal conductors shall be in separate conduits from power and control conductors. Motor feeder circuits shall be in separate conduits including small fan circuit unless combination fan-light fixture.
   2. Not used.
   3. Slices and terminations are subject to inspection by the Construction Manager prior to and after insulating.
   4. Motor terminations at 460-volt motors shall be made by bolt-connecting the lugged connectors.
   5. In-line splices and tees, where approved by the Construction Manager, shall be made with tubular compression connectors and insulated as specified for motor terminations. Splices and tees in underground handholes or pull boxes shall be insulated using Scotch-cast epoxy resin or Raychem splicing kits.
   6. Terminations at solenoid valves, 120 volt motors, and other devices furnished with pigtail leads shall be made using self-insulating tubular compression connectors within the termination box.
   7. Not used.
   8. Install and route multi-conductor as shown on the drawings. Submit installation and routing layouts of multi -conductor cables branching out to multiple field destinations to the Engineer for pre-approval. If approved, terminate on terminals in a terminal box located adjacent to the first field device served, or in the common junction boxlocated at the equipment as depicted on the motor feed standard detail Drawings. Make final connection to field devices with single conductors.

3.03 SIGNAL CABLE

A. Provide terminal blocks at instrument cable junctions within dedicated terminal boxes provided by the installer. Signal circuits shall be run without splices between instruments, terminal boxes, or panels.

B. Circuits shall not be made using conductors from different pairs or triads. Triads shall be used wherever 3-wire circuits are required.

C. Shields are not acceptable as a signal path, except for circuits operating at radio frequencies utilizing coaxial cables. Common ground return conductors for two or more circuits are not acceptable.

D. Unless otherewise specified, shields shall be bonded to the signal ground bus at the control panel only, and isolated from ground at the field instrument or analyzer and at other locations. Shields or drain wires for spare circuits shall not be grounded at either end of the cable run. Terminals shall be provided for running signal leads and shield drain wires through junction boxes.

E. Spare circuits and the shield drain wire shall be terminated on terminal blocks at both ends of the cable run and be electrically continuous through terminal boxes.

F. Where instrument cable splicing is required, provide an instrument stand with terminal box rated for the area and environment and mounted approximately 3 feet above grade for instrument cable splices with the circuits and individual conductors provided with nameplate as specified in Section 26 05 00.

G. Cable for telephone systems shall be installed and terminated in compliance with the manufacturers and the Utilities recommendations.

3.04 NOT USED

3.05 TESTING

A. The Contractor shall test conductors, wire, and cable in accordance with Section 26 08 00.

3.06 CABLE SPECIFICATION SHEETS (CABLESPEC)

A. General:
   1. Conductor, wire, and cable types for different locations, service conditions and raceway systems are specified on individual cable specification sheets. Scheduled and unscheduled conductors, wires, and cables shall be installed in accordance with the CABLESPEC Sheets.

B. CABLESPEC Sheets:
   1. The following CABLESPEC sheets are included in this section:

Type	Volt	Product	Purpose
DC1	300	RS-422: 4-PAIR, 24-AWG UNSHIELDED JACKETED PREMISE WIRE	DATA COMMUNICATION FAST ETHERNET: 100 BASE T CABLE

Type	Volt	Product	Purpose
MIC	600	SP-OS: MULTIPLE PAIR PR#18SH WITH OVERALL SHIELD AND JACKET	CABLE TRAY RATED INSTRUMENT CABLE
SIC	600	P-OS: 1-PR#18 or 1-TR#18	CABLE TRAY RATED INSTRUMENT CABLE
THWN	600	PVC INSULATED WITH NYLON JACKET BUILDING GRADE CONDUCTOR	LIGHTS & RECEPTACLES
XHHW	600	XLP INSULATED INDUSTRIAL GRADE CONDUCTOR	POWER, CONTROL, LIGHTING, & RECEPTACLES
MEPR / XLP	600	MULTICONDUCTOR RUBBER INSULATED CABLE WITH JACKET EXAMPLES: POWER CABLE: 3/C #500 KCMIL WITH FACTORY GROUND CONDUCTOR WITHIN CABLE CONTROL CABLE: 19/C #14	CABLE TRAY RATED POWER & CONTROL
MXLPE / S / PVC	1000	MULTICONDUCTOR SHIELDED MOTOR CABLE WITH PVC JACKET	FLEXIBLE 3/C CABLE WITH NEC GROUND CONDUCTOR. MOTOR FEEDER RANGE: 16 AWG - 500KCMIL
COAX		RADIO FREQUENCY CO-AXIAL CABLE	DATA COMMUNICATIONS

3.07 CABLE SPECIFICATION SHEETS (CABLESPEC) – DC1

A. Cable System Identification:
   1. DC1

B. Description:
   1. Premise Cable: IEC Category 6 UTP; NEMA WC-63.1 Category 6; Fast Ethernet: 100 Base TX; 4 pair, #24 AWG Cable

C. Voltage:
   1. 300 V RMS

D. Conductor Material:
   1. Solid Bare copper

E. Insulation Material:
   1. FRPO - Flame Retardant Polyolefin / FEP-Fluorinated Ethylene Propylene; Color Coded conductor insulation

F. Jacket:
   1. LS PVC - Low Smoke Polyvinyl Chloride with ripcord Trade Name Example: Flamarrest Sequential Footage Marking: every two feet Jacket Color:
      a. Blue.

G. Manufacturer(s):
   1. Cooper Industries – Belden 4813; or equal.

H. Execution:
   1. Applications:
      a. Gigabit Ethernet Data Communications LAN, Digital Video, RS-422,

2. Installation:
    a. Install in accordance with associated equipment manufacturer's instruction.
3. Testing:
    a. Test in accordance with paragraph 3.05.

3.08 CABLE SPECIFICATION SHEETS (CABLESPEC) – MIC

A. Cable System Identification:
    1. MIC

B. Description:
    1. Multiple twisted, shielded pairs, 18 AWG, with overall shield instrumentation cable; Number of pairs as shown; UL listed, Cable Tray rated.

C. Voltage:
    1. 600 volts

D. Conductor Material:
    1. Bare annealed copper; Class-B stranded per ASTM B-8

E. Insulation:
    1. 15 mil, Polyvinyl Chloride (PVC) with 4 mil nylon, 90 degree C temperature rated Color Code per ICEA Method-1: Pairs- Black and White with one conductor in each pair printed alpha-numerically for identification

F. Lay:
    1. Twisted on a 2-inch lay

G. Shield:
    1. 100 percent, 1.35 mil aluminum/polyester or mylar tape with 7-strand tinned copper drain wire

H. Overall Shield:
    1. 2.35 mil aluminum-Mylar tape with 7-strand tinned copper drain wire

I. Jacket:
    1. Flame-retardant, moisture and sunlight resistant 45 mil Polyvinyl Chloride (PVC)

J. Flame Resistance:
    1. UL 1685 vertical tray flame test

K. Manufacturer(s):
    1. Okonite, Okoseal-N type SP-OS (Shielded Pairs with Overall Shield); or Cooper Industries-Belden equal; or General Cable equal

L. Execution:
    1. Installation:
        a. Install in accordance with paragraph 3.03.

2. Testing:
    a. Test in accordance with paragraph 3.05.

3.09 CABLE SPECIFICATION SHEETS (CABLESPEC) – SIC

A. Cable System Identification:
    1. SIC

B. Description:
    1. Single twisted, shielded pair or triad, 18 16 AWG, instrumentation and signal cable; UL listed; Cable Tray rated

C. Voltage:
    1. 600 volts

D. Conductor Material: Bare annealed copper; stranded per ASTM B8

E. Insulation:
    1. 15 mil, Polyvinyl Chloride (PVC) with 4 mil nylon, 90 degree C temperature rated; Color Code per ICEA Method-1: Pairs-Black and White with one conductor in each pair printed alpha-numerically for identification

F. Lay:
    1. Twisted on a 2-inch lay

G. Shield:
    1. 100 percent, 1.35 mil aluminum-Mylar tape with a 7-strand tinned copper drain wire

H. Jacket:
    1. 45 mil Polyvinyl Chloride (PVC)

I. Flame Resistance:
    1. UL 1685

J. Manufacturer(s):
    1. Okonite, Okoseal-N Type P-OS (Pair(s) Overall Shield) and Type TOS (Triad(s) Overall Shield); or Cooper Industries-Belden equal; or General Cable equal

K. Execution:
    1. Use:
        a. Analog signal cable and RTD device Triad extension cable.
    2. Installation:
        a. Install in accordance with paragraph 3.03.
    3. Testing:
        a. Test in accordance with paragraph 3.05.

3.10 CABLE SPECIFICATION SHEETS (CABLESPEC) – THWN

A. Cable System Identification:
   1. THWN

B. Description:
   1. Single conductor lighting and receptacle type; Indoor branch circuit conductor.

C. Voltage:
   1. 600 volts

D. Conductor Material:
   1. Bare annealed copper; stranded per ASTM B8

E. Insulation:
   1. THWN/THHN, 90 degree C dry, 75 degree C wet,Polyvinyl Chloride (PVC) per UL 83.

F. Jacket:
   1. Nylon

G. Flame Resistance:
   1. UL 83

H. Manufacturer(s):
   1. Okonite, Okoseal-N, series 116-67-XXXX; or equal.

I. Uses Permitted:
   1. Lighting, receptacle and appliance circuits

J. Execution:
   1. Installation:
      a. Install in accordance with paragraph 3.02.
   2. Testing:
      a. Test in accordance with Section 26 08 00.

3.11 CABLE SPECIFICATION SHEETS (CABLESPEC) – XHHW

A. Cable System Identification:
   1. XHHW

B. Description:
   1. Industrial grade single conductor
   2. Sizes: 14 AWG through 750 kcmil as shown

C. Voltage:
   1. 600 volts

D. Conductor Material:
   1. Bare annealed copper; stranded per ASTM B8

E. Insulation:
   1. NEC Type XHHW-2; 90 degree C dry and C wet;
   2. Cross-Linked Polyethylene (XLP) per ANSI/NEMA WC70 ICEA S-95-658 and UL-44;
   3. Color in sizes 14, 12 and 10 AWG: Black, Green, Yellow, White, Orange, Brown, Red, Blue

F. Jacket:
   1. None

G. Flame Resistance:
   1. Not applicable

H. Manufacturer(s):
   1. Okonite, X-Olene; Cablec, Durasheath XLP; or equal.

I. Uses Permitted:
   1. Power, control, lighting and outlet circuits.

J. Execution:
   1. Installation:
      a. Install in accordance with paragraph 3.02.
   2. Testing:
      a. Test in accordance with Section 26 08 00.

3.12 CABLE SPECIFICATION SHEETS (CABLESPEC) – MEPR / XLP

A. Cable System Identification:
   1. MEPR / XLP

B. Description:
   1. Multiconductor Power Cable and Multiconductor Control Cable:14 AWG stranded conductors; Cable tray rated.

C. Power Cable:
   1. Insulated green grounding conductor sized per the NEC.

D. Ground Conductor Size:
   1. Multiple sets of multiconductor power cable:
      a. Oversize the grounding conductor per NEC 250.

E. Control Cable Type:
   1. ICEA Method 1, E-2, without white neutral conductor or green ground conductor

F. Control Cable Identification:
   1. Conductors color coded per ICEA and conductors numbered

G. Voltage:
   1. 600 volts

H. Conductor Material:
   1. Bare annealed copper; stranded per ASTM B8, coated per ASTM B33

I. Insulation:
   1. RHW/RHH, 90 degree C dry, 75 degree C wet, ethylene propylene rubber (EPR) per ICEA 2-68-516 and UL 44.

J. Jacket:
   1. Cross-linked Polyethylene (XLP).

K. Flame Resistance:
   1. IEEE 1202

L. Manufacturer(s):
   1. Okonite, Okonite-Okolon-Okoseal series 202-11-3XXX; Cablec, Durasheath EP; or equal.

M. Execution:
   1. Installation:
      a. Install in accordance with paragraph 3.02.
   2. Testing:
      a. Test in accordance with Section 26 08 00.

3.13 CABLE SPECIFICATION SHEETS (CABLESPEC) – MXLPE / S / PVC

A. Cable System Identification:
   1. MXLPE / S / PVC

B. Description:
   1. 1000 Volt Rated - Flexible Motor Supply Shielded Cable

C. Power Cable:
   1. Multi-conductor shielded motor feeder cable with PVC jacket:
      a. 3/C cable conductor minimum size is #12-AWG with grounding conductor.

D. Ground Conductor Size:
   1. Sized per NEC 250

E. Application:
   1. Feeder cable between VFD motor controller and motor.

F. Conductor Material:
   1. Flexible copper with high strand count

G. Insulation:
   1. Thermoset Crosslinked Polyethylene (XLPE):
      a. 90 degree C dry, 75 degree C wet, per UL 44.

H. Jacket:
   1. PVC over assembly; jacket thickness per UL 1277 Cable Tray rated UL 1277 Type TC

I. Shield:
   1. Tinned copper braid and foil

J. Flame Resistance:
   1. IEEE 383 Fire Test (70,000 BTU)
   2. IEEE 1202: Limited Smoke rated and labeled on cable jacket
   3. UL 1685: Vertical Tray Flame Exposure Test

K. Manufacturer(s):
   1. Anixter B2095XX series
   2. Belden 295XX series
   3. LAPPUSA OLFLEX VFD Symmetrical: 1AWG - 500kcmil LAPPUSA OLFLEX Servo 2YSLCY-JB flexible cable

L. Execution:
   1. Installation:
      a. Install in accordance with paragraph 3.02. Install in conduit or cable tray. Not to be used for open wiring installation. Ground shields at both ends. Shield terminating gland may be used at the motor to ensure grounding the shield.
   2. Testing:
      a. Test in accordance with Section 26 08 00.

3.14 CABLE SPECIFICATION SHEETS (CABLESPEC) – COAX

A. Cable System Identification:
   1. COAX

B. Description:
   1. Premise Cable: Indoor Riser and Plenum with FRPE Jacket Outdoor /Watertight:
      a. Ductbanks Systems with PE Jacket Low Loss Flexible Communication Coaxial Cable

C. Voltage:
   1. 300 V; Voltage Withstand: 3000 Volts DC;

D. Conductor Material:
   1. Solid 18 AWG;

2. Nominal Impedance: 50-ohm;
3. Nominal Capacitance: 20 Pico-Farad per foot;
4. Bend Radius: 2 inches

E. Insulation Material:
   1. Foam Polyethylene (PE) or Tetrafluoroethylene (TFE) UL Flame Test:
      a. NFPA-262 NEC Type Specification: CMP

F. Jacket:
   1. Polyethylene (PE), Fire Retardant Polyethylene (FRPE) or Fluorinated Ethylene Propylene (FEP)

G. Manufacturer(s):
   1. Times Microwave System: LMR-500;
   2. Belden Number 83242: 50-ohm Coax -- RG Type 142 B/U; or
   3. Engineer accepted equal.

H. Execution:
   1. Applications:
      a. Giga-Hertz Data Communications, CCTV Fixed.
      b. Component or Composite Video, Digital Video
   2. Installation:
      a. Install in accordance with associated equipment manufacturer's instruction. Provide male, female, TNC Male, UHF Male, straight, bulkhead, right-angle etc connectors, fittings, with crimp tools, dies, strip tools, deburr tools and cutting tools as required for the installation.
   3. Testing:
      a. Test in accordance with paragraph 3.05.

END OF SECTION

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SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies the system for grounding electrical distribution and utilization equipment, including but not limited to cabinets, motor frames, manholes, instrumentation, metal surfaces of process/mechanical equipment that contain energized electrical components, metal structures and buildings, outdoor metal enclosures, fences and gates.

B. The Equipment Grounding Conductor shall ground or bond equipment, structures, or equipment frames to the Grounding Electrode System as defined in the National Electrical Code (NEC) Article 250 and addressed herein.

C. The minimum size of the Equipment Grounding Conductors installed with the circuit conductors shall be per the NEC Table 250.122. The circuit grounding conductor size routed with a feeder or branch circuit conductors is as shown on the drawings.

1.02 REFERENCES:

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEEE 81	Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE Std 81.2-1991	Guide to Measurement of Impedance and Safety Characteristics of Large, Extended or Interconnected Grounding Systems
NETA - ATS	InterNational Electrical Testing Association Inc. - Acceptance Testing Specifications
NFPA 70	National Electric Code (NEC) Article 250

1.03 SUBMITTALS:

A. The following information shall be submitted for review in accordance with Section 01 33 00:

B. Action Submittals – Product Literature:

1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. Marked product literature for ground rods, test wells, and equipment ground plate.

C. Informational Submittals.

1. Ground resistance readings specified in Part 3.

PART 2 PRODUCTS

2.01 GROUND CONDUCTORS

A. The System Ground Conductor shall be soft-drawn, bare annealed copper, concentric stranded, as specified. The minimum sizes shall be as follows, where American Wire Gage (AWG) conductor sizes are not shown or specified:

1.	480V switchboards	2/0 or 4/0 AWG
2.	480V VFD and RVSS	2/0 or 4/0 AWG
3.	Lighting & Power panels	2 AWG
4.	Exposed metal cabinets	2 AWG
5.	Electrical equipment	2 AWG
6.	Buildings and enclosure	2 AWG
7.	Fences and gates	2 AWG
8.	Motors 25 hp to 250 hp	2 AWG
9.	Motors 1 hp to 25 hp	6 AWG

2.02 GROUND RODS

A. Ground rods shall be copper covered steel, 3/4-inch diameter and 10-feet long. Rods shall have threaded type removable caps so that extension rods of same diameter and length may be added where necessary.

2.03 COMPRESSION CONNECTORS

A. Compression connections shall be irreversible, cast copper as manufactured by Thomas and Betts, or equal.

2.04 BOLTED CONNECTORS

A. Bolted connectors shall be Burndy, O. Z. Gedney, or equal.

2.05 WELDED CONNECTORS

A. Exothermic welding products shall be Erico's Cadweld Plus system with a remotely operated battery powered electronic ignition device and moisture resistant weld metal cup for the required mold, or equal.

2.06 TEST WELLS

A. Provide concrete test well with cover and connect the ground grid extension using a removable connector.

2.07 EQUIPMENT GROUND BARS

A. Copper equipment ground bars shall be Erico Eritech EGB Series or equal, sized as required for the installation.

2.08 GROUND ELECTRODE GROUNDING BARS

A. Ground electrode grounding bars shall be 1/4-inch thick copper electro-tin plating, Erico Eritech EGBA Series CC Pattern, Burndy Type BBB or equal. Minimum length shall be 12 inches.

B. Insulators (Stand Off) material shall be halogen-free, fiberglass-reinforced thermal set unsaturated polyester molded compound with indoor rating of 600 volts.

C. Brackets shall be 1/8-inch thick, Type 304 stainless steel.

D. Fasteners shall be 3/8-inch Type 304 stainless steel.

2.09 EQUIPMENT GROUND PLATE

A. Equipment ground plate shall be two-hole copper flush mounted grounding plate, Erico Cadweld, Burndy YGF Series, or equal.

PART 3 EXECUTION

3.01 GENERAL

A. Grounding system shall be provided in compliance with the NFPA 70 National Electrical Code (NEC). Grounding conductor shall not be used as a system neutral.

B. Embedded and buried ground connections shall be made by compression connectors utilizing diamond or hexagon dies and a hand compression tool for wire sizes 2 AWG and smaller and a hydraulic pump and compression head for wire sizes 2/0 AWG and larger. Alternate method allowed: exothermic welding using a remote igniter device.

C. Tools and dies shall be approved for this purpose; dimple compressions are not acceptable. Compression connections shall be prepared in accordance with the manufacturer's instructions. Compression-type lugs shall be used in accordance with manufacturer's recommendations. Exposed ground connections to equipment shall be made by bolted clamps unless otherwise specified. No solder material shall be used in any part of the ground circuits.

D. Embedded ground conductors and fittings shall be securely attached to concrete reinforcing steel with tie wires and prevented from displacement during concrete placement.

E. Notify the Construction Manager two hours prior to backfilling, as each part of the grounding system installed below finished grade is complete and ready for inspection. Non-compliance shall affect the payment schedule for this work.

F. Grounding conductors extended beyond concrete surfaces for equipment connection shall be extended a sufficient length to reach the final connection point without splicing. Provide grounding fittings, pads, or plates as shown in the electrical details. Minimum grounding conductor extension shall be 3 feet.

G. Grounding conductors which project from a concrete surface shall be located as close as possible to a corner of the equipment pad, protected by rigid conduit bonded to the grounding conductors, or terminated in a flush grounding plate.

H. Exposed grounding conductors shall be supported by noncorrosive metallic hardware at 4-foot intervals or less. Grounding conductors for shown and future equipment shall be terminated using an equipment grounding plate.

I. Ground conductors entering electrical enclosures shall be bonded to a single ground bus or terminal strip in the enclosure and to metallic raceways within or terminating at the enclosure. Direct ground connections to enclosure chassis or back plate are not acceptable. Prior to making ground connections or bonds, the metal surface at the point of connection shall be cleaned.

J. Lightning arresters shall be directly connected to the ground grid system using lightning industry braided copper conductors, sized as specified.

K. Metallic sheaths or shields of shielded power cable shall be terminated by a copper ground bus provided with cable connection for connection to the grounding system.

L. Grounding system shall be separate from, and interconnected to, the Lightning Protection Grounding System.

M. Grounding system shall be separate from, and interconnected to the Radio Antenna/Transmission Grounding System.

3.02 RACEWAY GROUND

A. All service, feeder and branch circuit raceways shall contain a green insulated ground conductor sized per applicable NFPA 70 National Electrical Code (NEC) tables:
   1. T250.66 - Grounding Electrode Conductor for Alternating - Current Systems or
   2. T250.122 - Minimum Size Equipment Grounding Conductors for Grounding Raceways and Equipment.

B. Metallic conduits terminating at concentric knock-outs or reducing washers shall be bonded using insulated grounding bushings. Grounding bushings shall be connected to the grounding system using conductors sized in compliance with NEC.

3.03 EQUIPMENT AND ENCLOSURE BONDING

A. Electrical distribution and utilization equipment enclosure ground bus, motor frames, manholes, metal structures and buildings, outdoor metal enclosures, fences and gates shall be bonded to the grounding system with conductor sizes as specified.

B. Connect the conductor to the metal enclosure using a UL listed connector, where the enclosure does not contain an internal ground bus.

C. Non-electrical equipment with metallic enclosures, that are located outdoors and without a cover or a shade, shall be connected to the grounding system.

3.04 SERVICE AND SEPARATELY DERIVED SYSTEM BONDING

A. A neutral bonding jumper shall be installed in only one location for each service or separately derived system. The bonding jumper shall be located at the service source or the first immediate distribution point downstream from the source. The neutral and ground buses shall be kept isolated from each other accept where the bonding jumper is installed.

3.05 GROUNDING SYSTEM TESTS

A. The Contractor shall test the facility grounding system and the building grounding system to determine the ground resistance. The grounding test shall be Institute of Electrical and Electronics Engineers (IEEE) Standard 81 using the InterNational Testing Association (NETA) Fall-of-Potential procedure. A plot of ground resistance readings for each isolated ground rod, ground mat, or ground bus shall be submitted on 8-1/2 x 11 inch size graph paper. Point-to-point resistance measurements are not acceptable.

B. The current reference rod shall be driven at least 100 feet from the ground rod or grid under test or as recommended by IEEE Standard 81. The measurements shall be made at 10-foot intervals beginning 25 feet from the test electrode and ending 75 feet from it, in direct line between the ground rod or center of grid and the current reference electrode.

C. A grounding system that shows greater than 2 ohm resistance for the flat portion of the plotted data shall be considered inadequately grounded.

D. The Contractor shall add additional parallel connected ground rods and/or deeper driven rods until the ground resistance measurements meet the 2 ohm requirement. Additional ground rods will be paid for as extra work where the required numbers exceed that specified when authorized and approved by the Construction Manager.

E. Use of salts, water, or compounds to attain the specified ground resistance is not acceptable.

END OF SECTION

SECTION 26 05 33

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SCOPE

A. This section covers the furnishing and installation of electrical conduits, wireways, pull boxes, handholes, fittings and supports. Raceways shall be provided for lighting, receptacles, power, control, instrumentation, signaling and grounding systems.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI C80.1	Rigid Steel Conduit-Zinc Coated
ANSI C80.3	Electrical Metallic Tubing-Zinc Coated
ASTM F512	Smooth-Wall Polyvinylchloride Conduit and Fittings for Underground Installation
FEDSPEC WW-C-581E	Conduit, Metal, Rigid and Intermediate; and Coupling, Elbow, and Nipple, Electrical Conduit; Zinc Coated
FEDSPEC W-C-1094A	Conduit and Conduit Fittings, Plastic, Rigid
JIC EMP-1	Electrical Standards for Mass Production Equipment
NEMA ICS 6	Industrial Control and Systems Enclosures
NEMA TC2	Electrical Plastic Tubing (EPT) and Conduit (EPC 40 and EPC 80)
NEMA TC6	PVC and ABS Plastic Utilities Duct for Underground Installation
NEMA VE1	Cable Tray Systems
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NFPA 70	National Electrical Code (NEC)
NFPA 79	Electrical Standards for Industrial Machinery
IBC	International Building Code
UL 1	Flexible Metal Electrical Conduit
UL 6	Rigid Metal Electrical Conduit
UL 360	Liquid Tight Flexible Electrical Conduit
UL 514	Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers

Reference	Title
UL 651	Rigid Nonmetal Electrical Conduit
UL 797	Electrical Metallic Tubing
UL 870	Wireways, Auxiliary Gutters, and Associated Fittings
UL 884	Underfloor Raceways and Fittings
UL 886	Outlet Boxes and Fittings for Hazardous (Classified) Locations

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00 and 26 05 00:

B. Provide separate submittals for each of the Intake PS, LeChee WTP, and LeChee PS No. 3 for the following:

C. Action Submittals – Shop Drawings and Product Literature:

1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. Manufacturer's descriptive literature for materials.

D. Underground Conduit Raceway System:

1. The Contractor shall provide detailed layout drawings or sketches for the underground conduit raceway systems. Make take-offs of the circuits and underground raceways required between electrical power and control equipment, process equipment, instrumentation, area lighting, receptacles, heat tracing, and eye-wash stations to assure all circuit are included prior to system construction.
2. Drawings shall show plan view routing, pullboxes and manholes, consideration of other underground systems and structures, approximate system cover depths and widths, and section views showing sizes of conduits and circuits. Submit the underground conduit raceway systems drawings or sketches.
3. Layout drawings shall include areas shown on the following Contract Documents' Electrical Drawings, with addendum updates included.
   a. Intake PS: E-100 through E-103.
   b. LeChee WTP: E-00-101, E-00-111, E-00-131, E-00-311, E-00-321, and E-00-341.
   c. LeChee PS No. 3: E-100, E-101.

PART 2 PRODUCTS

2.01 RACEWAYS AND FITTINGS

A. General requirements for raceway materials specified in this section are listed in the RACESPECS sheets at the end of this section. The type of raceways and raceway fittings to be used for any given area and application shall conform to the requirements in this section.

2.02 BOXES, GUTTERS, TERMINAL CABINETS, MANHOLES, AND HANDHOLES

A. Materials and classifications of equipment and material is specified in Section 26 05 00

B. Pull Boxes And Wiring Gutters:
   1. Indoor boxes and enclosures larger than FD boxes shall be constructed of sheet steel and galvanized after fabrication. Outdoor boxes and enclosures shall be provided with neoprene gaskets on the hinged doors and removable covers. Box and gutter sizes, metal thickness, and grounding shall comply with the National Electrical Code. Bolt-on junction box covers 3 feet square or larger, or heavier than 25 pounds, shall have a rigid handle. Covers larger than 3 x 4 feet shall be split.

C. Terminal Cabinets:
   1. Terminal cabinets shall be provided with adjustable terminal strip mounting, back-panels for equipment mounting, print pockets in the doors, continuous door hinges, and three-point lockable latches. Terminal cabinets located indoors shall be National Electrical Manufacturers Association (NEMA) 12. Terminal cabinets located outdoors and in process areas shall be NEMA 4. Terminal block shall conform to Section 26 05 19.

D. Handholes:
   1. Handholes shall be precast concrete with checker plate, galvanized, traffic covers designed for H 20 loading. Handholes shall be provided with precast solid concrete slab bottoms with sumps. Handholes shall be constructed of 3000 psi reinforced concrete. Handhole cover shall be engraved "ELECTRICAL" or "SIGNAL" as applicable.
   2. Dimensions shall be as specified on the drawings. Handhole walls shall be provided with boxouts, as specified for manholes.

E. Handhole Cable Supports:
   1. Provide heavy-duty, non-metal cable racks for support of conductors. Racks shall be UL listed glass-reinforced nylon consisting of slotted wall brackets for support arms designed for a minimum of a 400-pound load. Each support bracket shall from the top to the bottom and the arms shall be adjustable and installed on 24-inch centers. Use ½-inch stainless steel bolts, hardware, inserts, and fasteners. Cables supports, clamps or racks shall be provided to support the cable at minimum 2-foot intervals. Concrete inserts shall be embedded on 24-inch centers in walls and ceiling.
   2. Cable Support Products:
      a. Underground Devices Incorporated Type RA arms with CR36 support brackets.
      b. Unistrut Power-Rack F20N-STA33 Stanchions with F20N-ARM14 Arms.
      c. Or equal

F. Ground Bus:
   1. Provide a ground bus in concrete manholes, handholes, and electrical pullboxes with dimension of 3-foot width x 3-foot length x 3-foot depth and larger. Provide a NEMA threaded, 4-hole grounding plate for connecting two to four-1-hole ground connectors that enter the enclosure from two to four duct banks. From each duct bank entry into the manhole, the continuous duct bank bare copper grounding conductor shall be supported and routed around the interior manhole walls and bonded together or to a ground bus.
      a. Products:
         1) Burndy, T&B, or equal.

2.03 RACEWAY SUPPORTS

A. Conduit Supports:
   1. Framing channel with end caps and straps shall be provided to support groups of conduitIndividual conduit supports shall be one-hole pipe straps used with clamp backs and nesting backs where required
   2. Conduit supports shall be one-hole clamps or oversized clamps with clamp backs and nesting backs where required .

B. Ceiling Hangers:
   1. Ceiling hangers shall be adjustable. Provide J-Type conduit support for single conduit. Straps or hangers of plumber's perforated tape are not acceptable. Unless otherwise shown, hanger rods shall meet ASTM A193 and be sized as 3/8-inch up to 2-inch conduit and shall be 1/2 inch all-thread rod over 2-inch conduit. .

C. Suspended Raceway Supports and Racks:
   1. Suspended raceway supports shall consist of concrete inserts, rod hangers, and jamb nuts supporting framing channel or lay-in pipe hangers as required. Framing channel shall be a minimum of 12-gauge.
   2. Hanger rods shall be 1/2-inch diameter all-thread rod and shall meet ASTM A193. Suspended raceway supports and racks shall be braced for seismic forces as specified in Section 26 05 00.

D. Materials:
   1. Mounting and supporting material and ratings are specified in Section 26 05 00

2.04 CONCRETE ENCASED DUCT BANKS

A. Concrete used for duct banks shall have a minimum strength of 3,000 psi and comply with Specification 03 30 00, Cast-in-Place Concrete.

2.05 UNDERGROUND MARKING TAPE

A. Underground detectable marking tape shall be for early warning protection of digging around direct buried cables, conduits, and concrete duct banks. Tape shall be OSHA approved.

B. Marking Tape Example:
   1. tape example: Low density polyethylene plastic, nominally 6 inches wide and 4 mil thickness with metallic lined tape with red polyethylene film on top and clear polyethylene film on the bottom. Tape shall be imprinted with a warning continuously along the length similar to: "CAUTION - STOP DIGGING - BURIED ELECTRIC LINE BELOW."

C. Tape Products:
   1. Brady "Identoline"; Services and Materials "Buried Underground Tape"; Somerset (Thomas & Betts) "Protect-A-Line"; or equal.

2.06 NAMEPLATES

A. Nameplates shall be provided for boxes in accordance with the requirements of Section 26 05 00. Nameplate wording shall be as shown on the Drawings. Provide the functional description of the device on the nameplate, where wording is not specified

2.07 NOT USED

2.08 RACEWAY IDENTIFICATION

A. Provide raceway numbering as specified in Section 3.06.

B. Raceway number tags:
   1. Solid aluminum with 0.036-inch minimum thickness.
   2. Raceway number stamped in 3/16-inch minimum height characters
   3. Attached to the raceway with 316 stainless steel wire.

2.09 ELECTRICAL SEALANT

A. Electrical sealant putty shall be non-hardening, non-oxidizing, non-corrosive, non-poisonous, and non-injurious to human skin with service temperature range of 30 to 200 degrees Fahrenheit. Product shall be used to seal against the entrance of water.

2.10 NOT USED

2.11 PULLING LINE

A. Pulling line shall be polyethylene type, mildew and rot resistant with minimum of 200-pound tensile strength and minimum 1/4-inch diameter. Install in all “future” or “spare” raceways. Manufacture: Greenlee, Ideal, or equal.

2.12 CONDUIT THREAD LUBRICANT

A. Thread lubricant shall be conductive with anti-seize and anti-corrosion properties, compatible with steel and aluminum conduit materials. Manufacture: T&B CP8 KOPR-Shield; Robroy Threadcompound; or equal.

2.13 TERMINAL BLOCKS

A. Terminal blocks are specified in Section 26 05 19.

PART 3 EXECUTION

3.01 GENERAL

A. Refer to Sections 01 61 45 and 26 05 00 for identification of hazardous and corrosive areas.

B. Table A specifies the type of raceway required for each location and application by RACESPEC sheet. Unscheduled conduit shall be galvanized, rigid steel, RACESPEC type GRS.

Table A

Location	Application/Condition	RACESPEC
Indoor noncorrosive	Exposed	GRS
Indoor corrosive, process areas	Exposed	PGRS
Outdoor	Exposed	GRS
Concealed	Power circuits embedded in concrete structure or beneath slab-on-grade	PVC4
Concealed	Instrumentation, communications and data signals encased in concrete, duct bank	PVC4
Underground	Power circuits encased in concrete, duct bank	PVC4
Underground	Instrumentation, communications and data signals directly buried	PVC4
Nonhazardous	Final connection to equipment and light fixtures	LFS
Architecturally finished areas	Concealed in framed walls and ceiling spaces (lighting and receptacle circuits only)	EMT
Architecturally finished areas	Final connection to light fixtures	FLEX

3.02 CONDUIT

A. General:
   1. The conduit systems, installation, and hazardous location fittings are specified herein.

B. Indoor and Outdoor Conduit Systems:
   1. In general, Contractor shall be responsible for determining conduit routing that conforms to the specified installation requirements:
      a. Conduits for lighting and outlets: Concealed
      b. Conduits for process equipment: Concealed
      c. Conduit inside structures: Concealed
   2. Conduit installation shall conform to the requirements of the RACESPEC sheets and the following specified installation requirements:
      a. Install exposed conduit parallel or perpendicular to structural members and surfaces. Install conduit horizontally and allow minimum headroom of 7 feet.
      b. Route two or more exposed conduits in the same general routing parallel with symmetrical bends.
      c. Space exposed conduit installed on supports not more than 10 feet apart. Space multiple conduits in parallel and use framing channel.

d. Comply with the requirements herein, where conduits are suspended from the ceiling.
e. Secure conduit rack supports to concrete walls and ceilings with cast-in-place anchors or framing channel concrete inserts.
f. Install conduits at least 6 inches from high temperature piping, ducts, and flues with temperatures higher than 90 degree C.
g. Install conduits between the reinforcing steel in walls or slabs that have reinforcing in both faces.
h. Place conduits under the reinforcement in slabs with only a single layer of reinforcing steel. Separation between conduits, conduits and reinforcement, and conduits and surfaces of concrete shall be maintained in accordance with UBC.
i. Route conduit clear of structural openings and indicated future openings.
j. Provide conduits with flashed and watertight seals routed through roofs or metal walls.
k. Grout conduits into openings cut into concrete and masonry structures.
l. Cap conduits or plug flush conduits during construction to prevent entrance of dirt, trash, and water. Cap or plug empty conduits designated as “future”, “spare”, or “empty” and include a pulling line accessible at both ends. Use anti-seize compound on cap and plug threads prior to installation.
m. Determine concealed conduit stubup locations from the manufacturer's shop drawings. Terminate concealed conduit for future use in specified equipment.
n. Install conduit flush with structural surfaces with galvanized couplings and plugs. Caps and plugs shall match the conduit system.
o. Provide concealed portions of conduits for future equipment where the drawings indicate future equipment. Match the existing installation for duplicate equipment.
p. Terminate conduits that enter enclosures with fittings that match the NEMA rating of the enclosure.
q. Underground metallic or nonmetallic conduit that turn out of concrete, masonry or earth: Install a 90-degree elbow of PVC-coated rigid steel conduit before emergence above ground.
r. Provide O-Z Gedney "Type DX" or Crouse-Hinds "Type XD" bonded, weathertight expansion and deflection fitting for the conduit size where conduit across structural joints that allows structural movement.

C. Underground Conduit System:
1. Excavation, backfilling, and concrete work shall conform to respective sections of these specifications. Underground conduit shall conform to the following requirements:
a. Underground conduits under roadways or traffic areas that are not shown otherwise on the drawings shall be reinforced concrete encased.
b. Concrete encased conduit shall have minimum concrete thicknesses of 2 inches between conduits, 1 inch between conduit and reinforcing, and 3 inches between reinforcing and earth, unless shown otherwise in an electrical detail.
c. Concrete encasement on exposed outdoor conduit risers shall continue to 3 inches above grade, with top crowned and edges chamfered.

d. Underground conduit bend radius shall be not less than 2 feet minimum at vertical risers and shall be not less than 3 feet elsewhere.

e. Where conduit and concrete encasement are terminated underground, the conduit and reinforcing shall both extend at least 2 feet past the concrete. Conduits shall be capped and threads protected. Steel surfaces shall be given two coats of epoxy paint.

f. Underground conduits and conduit banks shall have 2 feet minimum earth cover unless otherwise shown.

g. Underground conduit banks through building walls shall be cast-in-place or installed with concrete into boxouts with waterstops on all sides of the boxout. Water-stops shall be as specified in the Cast-in-Place Concrete section. Extend the horizontal reinforcement from the duct bank into the boxout terminating with J-hook bends.

h. Conduits not encased in concrete and passing through walls with one side in contact with earth shall be sealed watertight with special rubber gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.

i. Thoroughly swab conduits and raceways on the inside, immediately upon completion of pouring concrete.

j. Label raceways in accordance with 2.08 and 3.05.

k. After the concrete has set and before backfilling, pull a mandrel through each conduit. The mandrel shall have a diameter equal to the nominal conduit inside diameter minus 1/2 inch and shall not be less than 4 inches long.

l. If the mandrel showed signs of protrusions on the inside of the conduit, the conduit shall be repaired or replaced.

m. Provide manufactured plastic conduit spacers anchored to prevent movement during the concrete pour. Manufacture: Carlon, PW Pipe, Underground Devices, or equal.

n. Form the concrete pour ten feet from the wall, manhole, or handhole and form to allow for future conduit entry.

o. Backfill duct banks in accordance with Specification 31 23 00, Excavation and Fill. Allow for a minimum of two days to cure prior to backfilling.

p. Allow and provide for two offsets per conduit and raceway for each 100 linear feet to account for unexpected field conditions including for excavation and backfill limited to three feet of extra width and/or depth. Include these specified provisions in the bid price.

q. Provide PVC threaded adapter with female threads where PVC conduit is joined to steel conduit.

r. Procedure:

   1) Before assembly: Double coat steel conduit with Red-Robroy, Green-Permacote, Blue-Ocal or equal product.

   2) After assembly: Seal with 65-mil thick, 2-inch wide mastic sealing tape to 1/2 inch beyond threads. Procucts: 3M Scotch 2228; Plymouth 02625; or equal.

   3) Cover with 20-mil corrosion protection tape applied in ½-lap layers to 2 inch beyond threads. Products: 3M Scotchwrap 51; Plymouth Plywrap 12; or equal.

s. Where reinforced concrete duct banks enter the side of a building, manhole, or handhole and the reinforcement cannot be brought into a window and be terminated, then drill the structure and embed the reinforcement in epoxy to minimum of 3-inches depth.

t. Provide PVC conduit with bell ends where duct banks terminated at walls, manholes, or handholes. Install bell ends flush with finished concrete.

u. Provide PVC conduit with bell ends where conduit rise below grade into a floor mounted electrical panel, electrical cabinet, MCC, switchboard, or switchgear.

v. Separate power conduits from signal conduit within the same ductbank by 12 inches or greater separation, as shown. Refer to the drawings or schedules for signal to be installed in metal conduits instead of PVC ducts.

w. Separate high voltage ductbanks from low voltage ductbanks, as shown.

x. Provide wireways for transition from underslab conduits rising into wall-mounted panels where the number of conduits exceed the NEC allowable panel space in the bottom of the panel. Provide conduit sleeves or fitting for panel transition. Continuous thread or all-thread is prohibited.

D. Conduit In Block Walls

1. Install multiple runs of conduit that stub-up into a block wall and connect to recessed electrical panels with adequate space for the conduit. Coordinated the electrical work with the structural work and block installers to provide a chase to install the conduit. Install conduit in the cells that do not contain structural reinforcement. Install conduits in the center of the cell to avoid affecting the structural integrity of the wall.
2. Avoid conduit and electrical boxes installation that blocks the cell from being grouted or that blocks the cell reinforcing bars from being grouted. Avoid conduit in the first cell adjacent to doors, windows, corners and wall intersections and install conduits in the center of the first available cell a minimum of 1'-0" from the edge of these openings.
3. Where solid grouting of masonry walls is specified, install conduit and electrical boxes so as to provide sufficient space for grout to flow pass the boxes and conduit in order to fully fill the space beneath and behind. Where boxes need to be held in place, secure the boxes from the face of the block wall. Do not place items behind or next to electrical boxes to hold in place.
4. Coordinate split-face, slump and scored block installation with the masonry contractor to supply smooth face block at the location of receptacles and switches so that the device covers install flush to the wall. Install translucent weather-proof sealing material under device covers on outdoor or wet area locations.

E. Not used.

F. Conduit And Innerduct Sealing Material:

1. Provide HYDRA-SEAL® Handi-Polyurethane-Foam or equal product to seal conduits and innerducts.
2. Sealing product required features:
   a. Compatible with common cable jacket materials.
   b. ASTM E-84 flame spread requirements and UL Classified.
   c. Pre-pressurized, portable, one-component closed-cell foam sealing system.
   d. Dries tack-free within 15 minutes and cures within 24 hours.

e. Reacts with applied moisture or with ambient humidity.
f. Remove over-spray with acetone and remove cured foam mechanically

3. Application Criteria:
   a. Apply in ambient temperatures between 60 and 100 degrees Fahrenheit.
   b. Apply bead onto clean surface.

G. Conduits in Concrete Construction:
1. Conduits for power, control and instrumentation may be embedded in and pass through concrete construction subject to the limitations in this paragraph. Where concrete strength or serviceability requirements prevent the direct embedment of conduit, provide adequate support, bracing, and serviceability details:
   a. Do not impair significantly concrete strength by the embedment of conduits in or through structural sections.
   b. Provide conduit layout to the requirements of ACI 318, Sections 3.3 – Aggregates and 6.3 – Conduits and Pipes Embedded in Concrete.
   c. Treat conduits similarly to reinforcing steel for purposes of clearance. In general, code sections require conduit spacing the greater of:
   d. 1.33 times the maximum concrete aggregate size, clear
      1) Three diameters center to center
      2) Alternate spacing and layout shall be as reviewed and accepted by the Engineer.
2. Conduit and raceway penetrations through walls and slabs where:
   a. one side is a conditioned or an occupied space and the other side not, or
   b. one side has liquid or groundwater contact and the other not,
   c. be detailed and constructed to prevent liquid and moisture penetration through the wall or slab section for each conduit.

3.03 HANDHOLES

A. Unless otherwise specified, manhole and handhole installation shall be as follows:
1. Manholes, handholes, and pull boxes shall be set on a minimum of 6 inches of crushed rock on top of undisturbed or compacted earth.
2. Manholes and handholes shall be set plumb so that water shall drain to the sump.
3. Manhole covers shall be 36-inches in diameter and set at 2 inches above finish grade with surrounding pavement sloping away from the manhole cover.
4. Metallic hardware inside manholes and handholes shall be bonded to the ground plate or ground bus using bolted connections, bonding jumpers and grounding bushings.

B. CABLE RACKS: Cable rack assemblies shall be installed as follows:
1. Attach rack stanchion to manhole/handhole wall with ½-inch drop-in anchors and ½-x 3/8-inch stainless steel hex head cap screw. Stanchions shall be anchored at the top and bottom of each stanchion as well as above each cable arm.
2. Provide cable arms to support cables on each rack along the cable run within the manhole/handhole. Provide a minimum of two racks on each wall and two spare cable arms per rack.

3. Secure each cable or cable bundle to the cable arm with heavy duty, nylon wire ties, Richo WIT-225L or equal. Cable bundles shall be organized by circuit voltage and area served. Multiple circuits may be bundled together where the circuits are derived from the same immediate source and serve the same area. 480 volt AC circuits, No. 6 and larger, shall be individually bundled.

3.04 NOT USED

3.05 RACEWAY NUMBERING

A. Each new and reused conduit shall be provided with a number tag at each end and in each manhole, handhole, or pull box. Cable trays shall be identified by stencils at intervals not exceeding 50 feet, at intersections, and at each end to identify power cable tray voltage, control cable tray, or instrument cable tray.

B. Raceway Numbers:
   1. Tag raceways at all terminations. Raceway numbers wiil comply with raceway lables assigned on the drawings. Where raceway numbers have not been assigned, assigne raceway numbers in accordance with the following system:

Raceway Prefix	Type of Function
C	Control or power - 120V or less
H	Power above 600V
N	Pneumatic tubing
P	Power 208V to 600V
S	Signal - data communication or instrumentation
X	Spare

   2. Provide 4-digit number after the prefixes . Add a letter suffix to distinguish the raceways where more than one raceway is routed to a particular piece of equipment. Example: Raceway number = P3109A where:
      a. P = conduit contains power
      b. 3109 = unique 4-digit number
      c. A = letter to distinguish raceways to same equipment

3.06 NOT USED

3.07 RACEWAY SPECIFICATION SHEETS (RACESPEC) - EMT

A. Raceway Identification:
   1. EMT

B. Description:
   1. Electrical Metallic Tubing

C. Compliance:
   1. ANSI and UL

D. Finish:
   1. Electro-galvanized steel

E. Minimum size:
   1. 3/4 inch

F. Fittings:
   1. Compression type.
   2. Fittings inside concrete block (CMU) walls:
      a. Concrete-tight.

G. Boxes:
   1. Electro-galvanized sheet steel.
   2. NEMA Class 1 stamped or form-bent steel with screw covers.

3.08 RACEWAY SPECIFICATION SHEETS (RACESPEC) – GRS

A. Raceway Identification:
   1. GRS

B. Description:
   1. Galvanized Rigid Steel Conduit (GRS)

C. Compliance:
   1. ANSI and UL

D. Finish:
   1. Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces.

E. Manufacturers:
   1. Allied Tube and Conduit Corp., Wheatland Tube Co., or equal.

F. Minimum size:
   1. Unless otherwise specified, 3/4 inch for exposed, 1 inch for embedded, encased, or otherwise inaccessible.

G. Fittings:
   1. Locknuts, Rings, Hubs:
      a. Hot-dip galvanized insulated throat with bonding locknut or ring,. The hubs shall utilize a neoprene "O" ring and provide a watertight connection. O-Z Gedney, CHM-XXT, or equal
   2. Unions:
      a. Electro-galvanized ferrous alloy type Appleton UNF or UNY, Crouse-Hinds UNF or UNY, or equal. Threadless fittings are not acceptable.
   3. Conduit Bodies:
      a. Oversized conduit bodies: Ferrous alloy type with screw taps for fastening covers to match the conduit system. Gaskets shall be made of neoprene.

H. Boxes:
   1. Indoor:
      a. Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square.
   2. Outdoor:
      a. Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square.
   3. Corrosive and Process Areas:
      a. NEMA 4X stainless steel or nonmetallic, as specified.

I. Elbows:
   1. 3/4" thru 1-1/2" –- Factory fabricated or field bent.
   2. 2" thru 6" –- Factory fabricated only.

J. Conduit Bodies (Oversized):
   1. 3/4" thru 4" –- Malleable iron, hot-dip galvanized, unless otherwise noted. Neoprene gaskets for all access plates. Tapered threads for conduit entrances.
   2. 5" and 6" –- Electro-galvanized iron or cast iron box.

K. Expansion Fittings:
   1. Expansion fittings in embedded runs shall be watertight with an internal bonding jumper. The expansion material shall be neoprene allowing for 3/4-inch movement in any direction.

L. Manufacturers:
   1. Appleton, Crouse-Hinds, Hubbell, O. Z. Gedney, or equal.

M. Installation:
   1. Rigid steel conduit shall be made up tight and with conductive thread compound. Joints shall be made with standard couplings or threaded unions. Steel conduit shall be supported away from the structures using hot-dip galvanized malleable iron straps with nesting backs or framing channel.
   2. Conduit entering boxes shall be terminated with a threaded hub with a grounding bushing.
   3. Exposed male threads on rigid steel conduit shall be coated with zinc-rich paint.

3.09 RACEWAY SPECIFICATION SHEETS (RACESPEC) – LFS

A. Raceway Identification:
   1. LFS

B. Description:
   1. Liquidtight Flexible Steel Conduit

C. Application:
   1. Final connection to equipment subject to vibration or adjustment.

D. Compliance:
   1. UL 360

E. Construction:
   1. Spirally wound galvanized steel strip with successive convolutions securely interlocked and jacketed with liquidtight plastic cover.

F. Minimum Size:
   1. 3/4 inch

G. Fittings:
   1. Cadmium-plated malleable iron body and gland nut with cast-in lug, brass grounding ferrule threaded to engage conduit spiral.
   2. O-ring seals around the conduit and box connection and insulated throat.
   3. Provide forty-five and ninety degree fittings where applicable.
   4. Provide PVC coated flexible conduit and fittings where the conduit system is PVC coated.

H. Installation:
   1. Length of flexible liquidtight conduit shall not exceed 15 times the trade diameter of the conduit and not exceed 36 inches in length. Use conductive thread compound.

3.10 RACEWAY SPECIFICATION SHEETS (RACESPEC) –- PGRS

A. Raceway Identification:
   1. PGRS

B. Description:
   1. Rigid Steel Conduit, Corrosion-Resistant, Polyvinyl Chloride (PVC) Coated.
   2. Provide factory made and coated elbows.

C. Compliance:
   1. ANSI, ETL and UL. The PVC coated rigid galvanized steel conduit shall be stamped with the ETL Verification Mark “ETL Verified to PVC-001”.

D. Finish:
   1. PGRS shall be hot-dip galvanized rigid steel conduit as specified in Section 26 05 33-paragraph 3.08 GRS, with a PVC Coating. The PVC coating shall be gray, minimum 40 mils thick, bonded to the outside and continuous over the entire length of the conduit except at the threads, and be free of blisters, bubbles, or pinholes. Thread protectors shall be used on the exposed threads of the PVC coated conduit.
   2. A 2-mil coat of urethane enamel coating shall be bonded to the inside. Coating shall be free of pinholes. Bond strength shall exceed the tensile strength of the PVC coat.

E. Minimum Size:
   1. 3/4 inch

F. Fittings:
   1. Similarly coated to the same thickness as the conduit and provided with Type 316 stainless steel hardware. Conduit and fittings shall be manufactured by the same company Conduit and fittings shall be coated by the same company. Male threads on elbows and nipples, and female threads on fittings or conduit couplings shall be protected by application of urethane coating.

G. Covers:
   1. PVC coated covers shall have V-groove seal and stainless steel hardware.

H. Hubs:
   1. Hubs for connection of conduit to junction, device, or terminal boxes shall be threaded cast ferrous alloy.
   2. Hubs shall have the same PVC coating as the conduit and insulating grounding bushings. Hubs shall utilize a neoprene "O" ring and shall provide a watertight connection.

I. Boxes:
   1. Nonhazardous:
      a. NEMA Class 4X stainless steel or nonmetallic.

J. Manufacturers:
   1. PVC coated conduit that bears the ETL Verified PVC-001 label by Robroy Industries, Plasti-Bond, Perma-Cote, KorKap or equal.

K. Installation:
   1. Plastic coated conduit shall be made up tight, threaded, and installed using tools approved by the PVC-coated conduit manufacturer.
   2. Exposed conduit threads shall be covered by a plastic overlap coated and sealed per manufacturer's recommendations.
   3. Pipe wrenches and channel locks shall not be used for tightening plastic coated conduits. Damaged areas shall be patched, using manufacturer's recommended material. The area to be patched shall be built up to the full thickness of the coating. Painted fittings are not acceptable.
   4. PVC coated conduit shall be supported away from the structure using PVC coated conduit wall hangers or PVC coated conduit mounting hardware.
   5. Damaged work shall be replaced

L. Training:
   1. Installers shall be trained and certified in the proper installation techniques provided by the PVC-coated conduit system manufacturer. Proof of certification shall be provided under paragraph 1.03.

3.11 RACEWAY SPECIFICATION SHEETS (RACESPEC) – PVC4

A. Raceway Identification:
   1. PVC4

B. Description:
   1. Rigid Nonmetallic Conduit.

C. Application:
   1. Heavy wall thickness for direct bury, concrete encasement or surface mounting where not subject to physical damage.

D. Compliance:
   1. NEMA TC2, UL 651

E. Construction:
   1. Schedule 40, high-impact, polyvinylchloride (PVC)

F. Minimum size:
   1. 3/4 inch exposed; 1 inch embedded or encased

G. Fittings:
   1. PVC solvent weld type

H. Boxes:
   1. Indoor:
      a. NEMA Class 4, nonmetallic
   2. Outdoor and corrosive:
      a. NEMA Class 4X, nonmetallic

I. Installation:
   1. PVC conduit entering fiberglass boxes or cabinets shall be secured by threaded bushings on the interior of the box and shall be terminated with a threaded male terminal adapter having a neoprene O ring.
   2. Joints shall be made with standard PVC couplings.
   3. PVC conduit shall have bell ends where terminated at walls and boxes.

END OF SECTION

SECTION 26 05 74

ARC FLASH AND SHOCK RISK ANALYSIS, SHORT CIRCUIT STUDY

AND PROTECTIVE DEVICE COORDINATION REPORT

PART 1 GENERAL

1.01 DESCRIPTION

A. General:
   1. This section specifies that the Contractor subcontract an independent full member NETA Engineering and Study Firm / Testing Firm to prepare the following separately for each of the Intake PS, LeChee WTP, and LeChee PS No. 3:
      a. Electrical equipment short circuit study (SCS) for the new equipment being installed.
      b. Protective device coordination study (PDCS) report for the new equipment being installed in.
      c. Arc flash and shock risk analysis (AFA) and labeling for the new equipment being installed.

B. The Testing Firm shall be as described in Section 26 08 00 and shall also be responsible for the electrical testing described therein.

C. Scope:
   1. The Short Circuit and Protective Device Coordination Report shall include analysis including Utility Company equipment that affect the installed equipment's short circuit ratings, protective device ratings and protective device settings.
   2. Report shall also include analysis of the equipment's short circuit ratings, protective device ratings and protective device settings affected by the installed equipment.
   3. Report shall include the results of the arc flash and shock risk analysis study for energized electrical equipment in accordance with the methods outlined in IEEE Standard 1584 and stated hereinafter.
   4. Work shall include the fabrication of warning labels with the arc flash hazard analysis results and the installation of the labels on the equipment in accordance with NFPA 70E Article 130.5 that includes nominal system voltage, arc flash boundary, and at least one of the following:
      a. Available incident energy and corresponding working distance or
      b. Arc flash personnel protective equipment (PPE) level
      c. Minimum arc rating of clothing, site specific level of PPE.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEEE 141	Recommended Practice for Electric Power Distribution for Industrial Plants
IEEE 242	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
NETA ATS	Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems, latest version
NFPA 70E	Standard for Electrical Safety in the Workplace
NFPA 70	National Electrical Code

1.03 SCHEDULE

A. The report shall be completed, submitted to the Construction Manager for acceptance and reworked to include the Construction Manager comments and corrections, as required. The report shall be approved by the Construction Manager prior to purchase and fabrication of electrical equipment including switchgear.

B. A copy of the Construction Manager accepted report shall be sent by the Contractor to all affected manufacturers prior to fabrication.

1.04 SUBMITTALS

A. The report specified in this Section shall be provided in accordance with Section 01 33 00.

B. Action Submittal – Intake PS Report.

C. Action Submittal - LeChee WTP Report.

D. Action Submittal - LeChee PS No. 3 Report.

PART 2 PRODUCTS

2.01 REPORT

A. The product shall be a certified report summarizing the short circuit and coordination study and conclusions or recommendations which may affect the integrity of the electric power distribution system. As a minimum, the report shall include the following:

1. The equipment manufacturer's information used to prepare the study.
2. Power Utility Company system information applicable to the project.

3. Short circuit calculations listing short circuit levels at each bus. Provide a sketch of the bus and use both the project term and the bus-code-name to identify the bus, branches, sources, loads. Base the system on the Project One-Line diagram.
4. Coordination study time-current curves including the instrument transformer ratios, model numbers of the protective relays, and the relay settings associated with each breaker.
5. Comparison of short circuit duties of each bus to the interrupting capacity of the equipment protecting that bus.
6. Data used as input to the report that includes cable impedances, source impedances, equipment ratings for the equipment being purchased for the project, etc.
7. Arc flash hazard calculations listing incident energy levels at each bus.
8. Copy of the Arc flash warning labels displaying information in accordance with NFPA 70E requirments.
9. Assumptions made during the study.

PART 3 EXECUTION

3.01 GENERAL

A. Provide a short circuit and coordination study on the electrical power distribution system as specified and as described in Section 6.1 of NETA ATS. The studies shall be performed in accordance with IEEE Standards 141 and 242 and shall utilize the American National Standards Institute (ANSI) method of short circuit analysis in accordance with ANSI C37.010.

B. The studies shall be performed using actual equipment data for both existing and new equipment. The coordination study shall use the data from the same manufacturer of protective relay devices as being provided by the switchgear manufacturer.

C. For new equipment, the Contractor shall provide copies of final reviewed equipment submittals upon request by the Study Firm.

D. Not used.

E. Any power distribution equipment outages shall be scheduled in advance and coordinated with the Owner to limit process outages as required per plant process capacities.

3.02 QUALIFICATIONS

A. The short circuit and coordination report shall be performed by the Study Firm/ Testing Firm as described in Section 26 08 00. The studies shall be signed by the professional electrical engineer responsible for the studies and registered to practice engineering in the state in which the project is located.

3.03 SHORT CIRCUIT STUDY

A. The Contractor shall be responsible to obtain and verify all data needed to perform the study. As a minimum, the short circuit study shall include the following:
   1. One-Line Diagram
      a. Location and function of each protective device in the system, such as relays, direct-acting trips, fuses, etc.
      b. Type designation, current rating, range or adjustment, manufacturer's style and catalog number for all protective devices.
      c. Power, voltage ratings, impedance, primary and secondary connections of all transformers.
      d. Type, manufacturer, and ratio of all instrument transformers energizing each relay.
      e. Nameplate ratings of all motors and generators with their subtransient reactances. Transient reactances of synchronous motors and generators and synchronous reactances of all generators.
      f. Sources of short circuit currents such as utility ties, generators, synchronous motors, and induction motors.
      g. circuit elements such as transformers, cables, breakers, fuses, reactors, etc.
      h. Emergency as well as normal switching conditions, as applicable.
      i. The time-current setting of existing adjustable relays and direct-acting trips, as applicable.

B. Impedance Diagram:
   1. Available megavolt ampere (mVa), voltage, and impedance from the power utility company.
   2. Local generated capacity impedance.
   3. Bus impedance.
   4. Transformer and/or reactor impedances.
   5. Cable impedances.
   6. Equipment impedances.
   7. System voltages.
   8. Grounding scheme for the project:
      a. Resistance grounding, solid grounding, or no grounding.

C. Calculations
   1. Determine the paths and situations where short circuit currents are the greatest.
   2. Study shall address bolted faults and calculate the 3-phase and line-to-ground short circuits of each case.
   3. Calculate the maximum and minimum fault currents.

3.04 ARC FLASH HAZARD ANALYSIS AND SHOCK RISK ASSESSMENT

A. The Contractor shall be responsible to obtain and verify all data needed to perform the study. The arc flash analysis study shall include the following IEEE Standard 1584 nine step analysis process:
   1. Collect system and installation data.
   2. Determine modes of operation.
   3. Determine bolted fault current.
   4. Determine arc fault current.
   5. Determine protective device characteristic and arc fault duration.
   6. Document system voltages and equipment class.
   7. Select working distances.
   8. Calculate incident energy.
   9. Calculate the arc flash protection boundary.

3.05 PROTECTIVE DEVICE COORDINATION STUDY

A. As a minimum, the coordination study for the power distribution system shall include the following on 5-cycle, log-log graph paper:
   1. Time-current for each protective relay or fuse showing graphically that the settings will provide protection and selectivity within industry standards. Each curve shall be identified, and the complete protective relay settings shall be specified.
   2. Time-current curves for each device shall be positioned to provide for maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, the Construction Manager shall be notified as to the cause.
   3. Time-current curves and points for cable and equipment damage.
   4. Circuit interrupting device operating and interrupting times.
   5. Indicate maximum fault values on the graph.
   6. Sketch of bus and breaker arrangement.

3.06 IMPLEMENTING PDCS SETTINGS AND ARC FLASH SIGN INSTALLATION

A. The Study Firm/Testing Firm shall work with the Contractor to implement the protective device coordination study settings on new and existing equipment as required in Section 26 08 00, based on the Engineers accepted Protective Device Coordination Report specified herein and submit a final amended report of the As-Built electrical equipment protective device settings subsequent to start-up and testing.

B. The Study Firm/Testing Firm shall work with the Contractor for implementing the Arc Flash Hazard warning labels installation requirements for electrical equipment as specified in NEC Article 110.16 Arc-Flash Hazard Warning , and NFPA 70E.

END OF SECTION

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SECTION 26 08 00

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. The electrical equipment and conductors to be tested are specified herein and shown on the electrical drawings of the Contract Documents.
2. The Contractor shall retain an independent InterNational Electrical Testing Association (NETA) member Engineering and Testing Firm (Testing Firm) for specified on-site acceptance testing of the project electrical power distribution system and utilization equipment covered by this contract.
3. The Testing Firm shall be responsible for the Short Circuit and Protective Device Coordination Report as specified in Section 26 05 74. The Testing Firm shall verify the protective device settings are implemented in accordance with Section 26 05 74. The Testing Firm work includes the ARC-Fault equipment labeling work as specified in Section 26 05 74.
4. Tests performed by the Testing Firm shall be witnessed by the Owner's Representative. Provide the Construction Manager 30-day advanced notice for Testing Firm tests. Insulation tests by the Contractor typically will not be witnessed. Critical equipment witness testing may be requested by the Construction Manager.
5. The manufacturer of the electrical equipment supplied for the project shall complete their on-site factory inspection, testing, and setup prior to the Testing Firm's Acceptance Testing and subsequent Protective Device setting verification work. The power monitors shall be set up by the factory representatives and power monitor readings and settings verified by the Testing Firm. Manufacturer work is specified in the respective equipment sections.
6. The Installation Contractor shall test motors, conductors, and equipment as specified and shown. Contractor shall provide the labor, tools, material, including quality power sources required by the Testing Firm equipment, and other services necessary to provide specified tests and retesting.
7. Submit proposed electrical test procedures for tests to be performed by the Installing Contractor, other than insulation resistance testing, and proposed test procedures for tests to be performed by the Testing Firm.
8. Test procedures and results shall be submitted separately for each of the Intake PS, LeChee WTP, and Lechee PS No. 3.

1.02 QUALITY ASSURANCE

A. References

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/NETA ATS	International Electrical Testing Association (NETA) - Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems, latest version

B. Testing Firm:
   1. The Testing Firm and their proposed project team shall possess the following minimum qualifications:
      a. Testing Firm shall be an independent testing organization providing unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems to be evaluated.
      b. Testing Firm shall be regularly engaged in the testing of electrical equipment, devices, installations, and systems.
      c. Testing Firm shall be a “NETA Accredited Company” of the InterNational Electrical Testing Association (NETA providing testing in accordance with ANSI/NETA ATS published specifications or the pre-approved firms that use the NETA methods and published testing specifications.
      d. If firm's own published testing specifications are proposed, then submit a copy to the Engineer for acceptance and submit the qualifications of the testing staff.
      e. Testing Firm's lead technical person shall be currently certified by NETA or the National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution systems testing. Submit proof of technical training and certification for performing testing work.
      f. Testing Firm's technicians shall be regularly employed, qualified testing staff.
      g. The following are pre-qualified Testing Firms:
         1) Emerson Electrical Reliability Services.
         2) Power Systems Testing Co.
         3) Southwest Energy Systems.

C. Testing Firm Qualifications:
   1. For any Testing Firm not pre-qualified, the Contractor shall receive Construction Manager approval of the proposed Testing Firm, their proposed project team, and their test procedures prior to the Pre-Test Submittals.
      a. Project Team:
         1) Identify lead technical person and testing staff and provide documentation of training and experience demonstrating compliance with the qualifications specified.

b. Testing Firm:
    1) Provide reference names and current phone numbers of the Owner, Contractor, Engineer, or Construction Manager that has knowledge of the Firm's work:
        a) Three projects for Owner completed within the past four years, or
        b) Three projects for Brown and Caldwell completed within the past four years, or
        c) Provide references for five recent projects that were completed within the last four years. Provide a description of the scope of the referenced project.
c. For Testing Firm's experience to be judged acceptable, the Contractor shall demonstrate that the proposed Testing Firm's reference projects are of similar scope and size to this project, and in performing these projects the following has been achieved:
    1) Testing Firm's work did not delay the projects or adversely impact the progress of the Contractor's work or the Owner's project.
    2) Specified requirements were achieved.
    3) Work was performed in accordance with ANSI/NETA ATS, MTS, or other Engineer accepted testing criteria.
    4) Submittals approved with two or fewer re-submittals after the initial submittal.
    5) No warranty claims related to the Testing Firm's work.
d. Provide documentation demonstrating NETA Accreditation and compliance with the qualification specified.

1.03 SUBMITTALS

A. Contractor shall submit the following information in accordance with specification Sections 01 33 00 and 26 05 00.

B. Action Submittal – Testing Firm Qualifications:
    1. For any Testing Firm not pre-qualified per paragraph 1.02 C, submit qualifications per paragraph 1.02 C. Qualifications shall be submitted separately and prior to Pre-Test Submittals.

C. Provide separate submittals for each of the Intake PS, LeChee WTP, and LeChee PS No. 3 for the following:

D. Action Submittal – Testing Firm Pre-Test Submittals:
    1. Description or samples of specified test procedures.
    2. Sample test report forms for the specified tests.

E. Action Submittal – Contractor Pre-Test Submittals:
    1. Preliminary Schedule listing equipment to be tested.
    2. Notification form for the work scheduled.
    3. Pre-Functional test procedures and testing schedule.
    4. Functional test procedures and testing schedule.

F. Informational Submittal – Contractor Post-Test Submittals:
   1. Completed Section 01 99 90 Test Records:
      a. Wire and Cable Resistance Test Data Form: 26 05 00-A, 40 61 13-A.
      b. Installed Motor Test Form: 26 05 00-B.

G. Informational Submittal – Testing Firm Post-Test Submittals:
   1. Test Reports specified in Part 3 of this Section.

PART 2 PRODUCTS

2.01 TESTING EQUIPMENT AND INSTRUMENTS

A. The test equipment, instruments and devices used for testing shall be calibrated to test equipment standards with references traceable to the National Institute of Standards and Technology (NIST).

B. The test equipment, instruments and devices shall have current calibration stickers indicating date of calibration, deviation from standard, name of calibration laboratory and technician, and date of next recalibration.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall submit a schedule for the Testing Firm work and notify the Construction Manager 30 days prior to commencement of any witnessed testing.

B. The required tests, including correction of defects where found, and subsequent retesting, shall be completed prior to energizing electrical distribution system, utilization systems, and conductors and completed prior to functional testing. The installation of the protective device, breaker, and relay settings shall be completed and verified.

3.02 INSTALLATION CONTRACTOR TESTING

A. General:
   1. Submit all completed test report forms in a 3-ring binder type notebook at the project Substantial Completion date.

B. Insulation Resistance Measurements:
   1. Tests:
      a. Insulation resistance measurements shall be made on conductors and electrical equipment that will carry current. Where not specified, the minimum acceptable values of insulation resistance shall be in accordance with the applicable NETA-ATS, Insulated Cable Engineers Association (ICEA), National Electrical Manufacturers Association (NEMA), or ANSI standards for the equipment or material being tested.
   2. The ambient temperature at which insulation resistance is measured shall be recorded on the test form. A megohmmeter shall be used for insulation resistance measurements.

3. Refer to specification Section 01 99 90 for the test forms required to document the testing performed by the Installing Contractor.
4. Conductor and Cable Tests:
    a. The phase-to-ground insulation resistance shall be measured for circuits 120 volts and above except lighting circuits. Measurements may be made with motors and other load equipment connected. Insulation resistance measurements shall be recorded on Form 26 05 00-A contained in Section 01 99 90, and submitted. Insulation with resistance of less than 100 megohms is not acceptable.
5. Motor Tests:
    a. The Installed Motor Test Form, Form 26 05 00-B, contained in Section 01 99 90, shall be completed for each motor after installation and submitted. All motors shall have their insulation resistance measured before they are connected.
6. Motors 50 HP and larger shall have their insulation resistance measured at the time of delivery and when they are connected. Insulation resistance values less than 50 megohms are not acceptable.
7. Verify that motors are connected to rotate in the correct direction with the load disconnected. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation.
8. Motor running current shall be measured on each phase with the motor operating under load. Current imbalance shall be less than 5-percent difference between phases.

C. Power Distribution Equipment:
1. Transformers, panelboards, and other power distribution equipment shall have their insulation resistance measured phase-to-phase and phase-to-ground. Insulation resistance values less than 10 megohms are not acceptable.

D. Power Utilization Equipment:
1. Test receptacles and power outlets using a device to verify polarity, grounding, and the correct wiring connections.

E. Signal and Data Cable Tests:
1. Signal conductors and shield drain shall be tested for insulation resistance with the other conductors in the cable grounded. Each shield drain conductor shall be tested for continuity. Insulation resistance measurements shall be recorded on Form 40 61 13-A contained in Section 01 99 90, and submitted.
2. Instruments used for continuity measurements shall have a resolution of 0.1 ohms and an accuracy of better than 0.1 percent of reading plus 0.3 ohms. A 500-volt or 1000-volt meg-ohmmeter shall be used for insulation resistance measurements as appropriate.

F. Pre-Functional Checkout:
1. Prior to energizing equipment, the Contractor shall perform a pre-functional checkout of the power and the control circuit. Protective devices shall be installed and available for service and calibrated or adjusted with specified setpoints installed. Contractor selected initial setpoints shall be installed and recorded, when specified setpoints are not required from the manufacturer or the Engineer.

2. Contractor shall submit a description of proposed test and checkout procedures conforming to the following requirements, including a schedule for conducting these procedures, not less than 30 days prior to the performance of pre-functional testing.
3. Pre-functional checkout shall consist of energizing each control circuit and operating each control device, protective device, monitoring or alarm device, and each interlock and verify the specified action or response occurs. Coordinate testing with the requirements specified in Section 01 45 20.

G. Functional Testing:
1. Contractor shall submit a description of proposed functional test and checkout procedures conforming to the following requirements, including a schedule for conducting these procedures, not less than 30 days prior to the performance of functional testing.
2. Prior to functional testing, all protective devices shall be adjusted and made operative. Prior to energization of associated equipment, perform a functional checkout of all electrical and instrumentation control circuits as specified in the following and in Division 40. Checkout shall consist of energizing each control circuit and operating each control, alarm, safety device, and each interlock, in turn, to verify that the specified action occurs.
3. Record and submit data sheets as specified. Coordinate testing with the requirements specified in Section 01 45 20.

3.03 TESTING FIRM ACCEPTANCE TESTING REQUIREMENTS

A. Acceptance Test Reports:
1. The Contractor shall maintain a written record of all inspection and test results and, upon completion of the project, shall assemble and certify a final test report.
2. A copy of the preliminary test results shall be provided to the Construction Manager at the end of each day of testing.
3. Furnish two copies of the complete acceptance testing final report to the Construction Manager at Substantial Completion of the project.

B. Acceptance Test Documentation: The Contractor shall submit test documentation forms and a detailed description of the proposed inspection and test procedures to be performed by the Testing Firm. Testing shall not commence until the Construction Manager has approved the proposed forms and procedures.

C. The description shall identify the test equipment required for each specified test to be performed. Test report forms shall include the following information:
1. Electrical equipment description.
2. Electrical equipment identification number.
3. Electrical equipment nameplate data.
4. Electrical equipment settings.
5. Time and date of test.
6. Ambient conditions at time of test.
7. Inspection checklist and results.
8. Test results.
9. Test equipment used with manufacture, model number, and calibration date.

10. Remarks about test procedures, results, and suggestions.
11. Name and signature of testing personnel.
12. Name and signature of test witness.

D. Acceptance Testing Firm Tests:
   1. Acceptance testing procedures and test results shall be as specified in ANSI/NETA ATS. The following types of equipment and systems shall be inspected and tested by the Testing Firm. Acceptance testing work shall not be limited to equipment shown on the drawings. Refer to Division 26 specification for the electrical equipment specified.
      a. Refer to the electrical drawings for location and identification of the electrical distribution system equipment, utilization equipment, and electrical conductors, included but not limited to:
         1) Switchboard Assemblies.
         2) Transformers Dry-Type Air-Cooled.
         3) Cables Low-Voltage 600 Volt Maximum.
         4) Circuit Breakers Low-Voltage, 100A frame and larger.
         5) Protective Relays.
         6) Instrument Transformers.
         7) Metering, include non-utility power metering equipment.
         8) Grounding Systems include installed grounding systems and existing grounding systems that are being utilized.
         9) Ground Fault Protection Systems.
         10) Motor Starters Low-Voltage.
         11) Adjustable Speed Drive Systems and harmonic testing per Section 26 29 23-3.02.
         12) Surge Protection Devices, include lightning arresters, surge capacitors.
         13) Engine Generators.
         14) Automatic Transfer Switches (ATS).

3.04 ACCEPTANCE TEST VALUES

A. Minimum acceptable test values shall be as specified in ANSI/NETA ATS. Where acceptance test values are not specified, the equipment manufacturer's recommended test values shall be used. Where acceptance test values are not specified and the equipment manufacturers recommended test values are not available, request acceptance test values from the Construction Manager.

3.05 ACCEPTANCE TEST FINAL REPORT

A. Test report shall be assembled as described in ANSI/NETA ATS. Test results shall be organized by electrical distribution system equipment, project utilization equipment, and electrical conductors with individual tab dividers with labels to identify each group of items and cross-referenced to the Contract Documents. The equipment description, equipment number, and equipment tag number shall be used as shown on the drawings or listed in Specifications.

B. Final Test Reports that are illogically assembled, labeled, and organized shall be returned for rework at no cost to the Owner and resubmitted in an acceptable format.

C. Deficiencies and non-compliant test results found during acceptance testing shall be identified in the test report and cover letter. The Testing Firm shall certify in the final test report that all deficiencies and non-compliant test results listed have been “corrected” and shall include a description of the resolution for each problem listed.

3.06 PROTECTIVE DEVICE FIELD SETTINGS

A. The Testing Firm shall verify, and certify in the acceptance test final report, that the protective device coordination study settings for new and existing equipment based on the Short Circuit and Protective Device Coordination Report specified in Section 26 05 74 have been implemented and recorded on the Testing Firm’s Data Sheets.

3.07 ARC FLASH STUDY RESULTS

A. The Testing Firm shall provide and install labels on the project electrical equipment for personnel protective clothing requirements as specified in Section 26 05 74.

END OF SECTION

SECTION 26 09 16

ELECTRICAL CONTROLS AND RELAYS

PART 1 GENERAL

1.01 DESCRIPTION

A. The vendor, manufacturer, and custom control panels shall provide enclosures, selector switches, pushbuttons, indicators, terminal strips, surge devices, nameplates, testing procedures, wiring method, wiring color coding, wire labeling, separation between power, controls, and instruments, hardwired logic relays or PLC logic products as specified herein and in Section 40 67 00.

B. This section specifies electrical control and monitoring devices:
   1. Pushbuttons
   2. Selector Switches
   3. Indicating Lights
   4. Control Station Enclosures
   5. Beacons
   6. Thermostats
   7. Elapsed Time indicators

C. This section specifies Control Relays:
   1. Load-Switching
   2. Timers

D. This section specifies power devices:
   1. Motor Terminator.

E. This section specifies specialty contactors:
   1. Intrusion Switches

F. Request clarification where conflicts occur with this section and other sections in Divisions 23, 26, 40, 43, and 46.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid or on the effective date of the Agreement if there were no Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NEMA ICS-1	General Standards For Industrial Controls and Systems
NEMA ICS-2	Industrial Control Devices, Controllers, and Assemblies

1.03 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 00 and Section 40 67 00.

B. Action Submittals – Product Literature:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. Manufacturer's catalog data for all material provided under this section.

PART 2 PRODUCTS

2.01 CONTROL DEVICES

A. Pushbuttons:
   1. Pushbuttons shall be flush head, heavy-duty, with NEMA rating to match enclosure type. Operators shall be green for start function, red for stop functions, and black for all other functions. The escutcheon legend shall be as specified on the drawings.
      a. UL Listed.
      b. Dielectric Strength: 1300 Volts for one minute for Logic Reed contacts, 2200 Volts for one minute for other contacts.

c. 30.5mm mounting hole.
d. Temperature operating range -10 degree C. to +55 degree C.
e. Momentary contact type.
f. When switching circuits are monitored by programmable controllers or other solid state circuits, furnish hermetically-sealed, logic-reed type contacts rated not less than 0.15 amperes at 150 Vac and 0.06 amperes at 30 Vdc.
g. When switching circuits are not monitored by programmable controllers or other solid state circuits, furnish contacts with NEMA Utilization Category rating A600 rated not less than 10 amperes continuous and 6 amperes break at 120 Vac.

2. Manufacturer: Allen-Bradley 800T/800H series or equal.

B. Selector Switches:
1. Selector switches shall be heavy-duty with NEMA rating to match enclosure type. Selector switches shall have maintained position contacts. Switches shall be provided with contact blocks and number of positions as required performing the specified or indicated operations.
2. The escutcheon legend shall be as specified on the drawings. Provide:
a. UL Listed.
b. Dielectric Strength: 1300 Volts for one minute for Logic Reed contacts, 2200 Volts for one minute for other contacts.
c. 30.5mm mounting hole.
d. Temperature operating range -10 degree C. to +55 degree C.
e. Standard knob operator (not lever type nor wing lever type).
f. Number of positions and contact configuration as shown on Drawings.
g. When switching circuits are monitored by programmable controllers or other solid state circuits, furnish hermetically-sealed, logic-reed type contacts rated not less than 0.15 amperes at 150 Vac and 0.06 amperes at 30 Vdc.
h. When switching circuits are not monitored by programmable controllers or other solid state circuits, furnish contacts with NEMA Utilization Category rating A600 rated not less than 10 amperes continuous and 6 amperes break at 120 Vac.
3. Manufacturer: Allen-Bradley 800T/800H series or equal.

C. Indicating Lights:
1. Red, amber, green, and blue indicating lights shall be heavy-duty full voltage 120Vac or 24Vdc push-to-test LED type with NEMA rating to match enclosure type for installation in a 30.5mm hole. Furnish with 28 chip high visibility LED. The escutcheon and lens color shall be as shown on Drawings or scheduled.
2. White indicating lights shall be as above, incandescent type lamp.
3. Manufacturer:
a. Allen-Bradley 800H-QRTH10 series or equal for 120Vac applications with colors other than white.
b. Allen-Bradley 800HQRTH24 series or equal for 24Vdc applications with colors other than white.
c. Allen-Bradley 800H-QRT10 series or equal for 120Vac applications with white.
d. Allen-Bradley 800H-QRT24 series or equal for 24Vdc applications with white.

4. Indicating Light Lens Color:

Lens Color	Typical Function	Example
Red	Danger, running, open	Equipment operating, motor running, valve open, power voltage applied, cycle in automatic
Amber	Fault condition, attention	Equipment failure, status abnormal
Green	Off, closed, ready	End of cycle; unit or head returned; motors stopped; motion stopped; contactors open, valve closed
White or Clear	Normal condition	Normal pressure of air, water, lubrication, control power on, status okay
Blue	Advisory	Control mode not in automatic

D. Control Station Enclosures:
   1. Enclosures locations and ratings:
      a. Refer to Section 26 05 00.

E. Beacons:
   1. The alarm beacon shall be a 75-watt sealed-beam lamp with motor driven rotating reflector; Beacon shall be for 120-volt AC service and shall be Federal Signal Model 191XL or equal.
   2. Each beacon located standalone shall include a 6 x 10 inch Red with white letter lamicoid nameplate with the specific warning such as the following:
      a. CHLORINE LEAK.
      b. As needed for each application.

F. Thermostats:
   1. Thermostats shall be line voltage type with motor current rated contact and 70-degree to 140-degree Fahrenheit setpoint range.
      a. Manufacturer: Honeywell T631A-1022 or equal.

G. Elapsed Time Indicators:
   1. Elapsed time indicators shall be panel mounted, non-resettable, 5.5-digit, hour indicator, rated 120Vac, 60-Hertz.
      a. Manufacturer: Trumeter 722-series or equal.

2.02 CONTROL RELAYS

A. Load-Switching Control Relays:
   1. Control relays used for switching loads such as solenoids, actuators, contactors, motor starter coils, remote interlocking, etc. shall be heavy-duty machine tool type.
   2. Contacts shall be 4-pole and be field interchangeable to either normally-open or normally- closed. Relay shall be capable of accepting a 4-pole adder.
   3. AC relays shall have NEMA A600 contact ratings and electrical clearances for 600 volts. DC relays shall have NEMA P300 contact ratings and electrical clearances for 250 volts.
   4. Manufacturer:
      a. Allen Bradley Bulletin-700.

b. Square D Class 8501.
c. or equal.

B. Timers:
1. Multi-function, micro-controller based, socket mounted timing relay.
2. Single functions:
a. Delay on Make.
b. Delay on Break.
c. Recycle (on time first, equal recycle delays).
d. Single shot.
e. Interval.
f. Trailing edge single shot.
g. Inverted single shot.
h. Inverted delay on break.
i. Accumulative delay on make.
j. Re-triggerable single shot.
3. Dual functions:
a. Delay on make/delay on break.
b. Delay on make/recycle (on time first, equal recycle delays.)
c. Delay on make/interval.
d. Delay on make/single shot.
e. Interval/recycle (on time first, equal recycle delays).
f. Delay on break/recycle (on time first, equal recycle delays).
g. Single shot/recycle (on time first, equal recycle delays).
h. Recycle – both times adjustable (on time first).
i. Recycle – both times adjustable (off time first).
j. Interval/delay on make.
k. Accumulative delay on make/interval.
4. Time delay range, switch selectable:
a. Single function 0.1 second to 1,705 hours in 8 ranges.
b. Dual function 0.1 second to 3,100 minutes in 8 ranges.
c. Setting accuracy +/- 1 percent or 50 milliseconds, whichever is greater.
d. Repeat accuracy +/- 0.1 percent or 16 milliseconds, whichever is greater.
5. Output:
a. Two Form-C electromechanical isolated contacts rated 10-amperes resistive at 240Vac.
b. Rated 1/3-horsepower at 120 or 240Vac.
c. Double-pole double-throw: DPDT.
d. Mechanical life: 10,000,000 operations.
6. Electrical life: 1,000,000 operations at full load.
a. Mounting: Magnal Plug 11-pin socket.
7. Environment: -20 to +65 degree C.

8. Manufacturer:
    a. ABB / SSAC's multifunction type TRDU time delay relay with dip-switch function setting with 12Vdc, 24Vac, 120Vac, 240Vac inputs as required or indicated or equal.

2.03 POWER DEVICES

A. Motor Terminator:
    1. NEMA 4X. Rockwell Automation 1204-TFB2 or equal.

2.04 SPECIALTY CONTACTORS

A. Intrusion Device:
    1. The intrusion switch shall be wide-gap industrial grade magnetic door switch with maximum gap 2.5 inches between the sensing elements. The magnet element shall be mounted on the moving part of the door. The sensor switch shall close when the door is closed. The sensor switch shall open when the door is opened. Provide with appropriate mounting bracket for the entrance doors.
    2. Manufacturer:
        a. George Risk Industries Series 4400.
        b. or equal.

2.05 NAMEPLATES

A. Nameplates for all control stations, relays, timers, and motor contactors shall be provided in accordance with the requirements of Section 26 05 00-2.02.

PART 3 EXECUTION

3.01 INSTALLATION

A. Control stations shall be mounted 48 inches above the floor, ground, or slab to center of device.

B. Devices shall be tested in accordance with Section 26 05 00 and Section 26 08 00.

C. Provide motor terminators at all Intake PS pumps.

END OF SECTION

SECTION 26 21 16

LOW-VOLTAGE UNDERGROUND ELECTRICAL SERVICE ENTRANCE

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies outdoor rated, 480Vac, four-wire, Service Entrance Section (SES) with Navajo Tribal Utility Authority (NTUA) power utility metering equipment and main disconnecting means as shown on the drawings.

B. The SES for the Intake PS and LeChee WTP shall consist of the following:
   1. Outdoor NEMA-3R, non-walk-in enclosure.
   2. Enclosure Section 1:
      a. Power utility metering compartment that meets the EUSERC standards.
   3. Enclosure Section 2:
      a. Includes the fixed insulated-case power circuit breaker with solid state trip "Main" circuit breaker.
      b. Ground fault interrupting system initially set to the maximum setting.
      c. Surge protective device (SPD).

C. The SES for the LeChee PS No. 3 is specified on the drawings.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NEMA PB 2	Deadfront Distribution Switchboards
UL 489	Underwriters Laboratory – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 891	Underwriters Laboratory - Deadfront Switchboards
UL 943	Underwriters Laboratory – Ground-Fault Circuit-Interrupters

Reference	Title
UL 1066	Underwriters Laboratory – Low Voltage AC and DC Breakers used in Enclosures

B. Factory Tests:

1. Switchboards shall be tested for operation at the specified voltage and current ratings after assembly. The main circuits shall be given a dielectric test of 2200 volts for 1 minute between live parts and ground, and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500 volts for 1 minute between live parts and ground.
2. Instrument transformers shall have ratio- and phase-angle tests made in conformance with American National Standards Institute (ANSI) C57.13.

1.03 SUBMITTALS

A. The following information shall be submitted in accordance with Sections 01 33 00 and 26 05 00.

B. Provide separate submittals for each of the Intake PS, LeChee WTP, and LeChee PS No. 3 for the following:

C. Action Submittals – Shop Drawings and Product Literature:

1. A copy of this Specification section, Section 01 73 24, and Section 26 43 13, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. A copy of the following Contract Documents' Electrical Drawings, with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "NO CHANGES REQUIRED." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   a. Intake PS: S-001, E-100, E-103, E-104, and E-106.
   b. LeChee WTP: S-00-001, E-00-101, E-00-501, and I-00-101.
   c. LeChee PS No. 3: E-100, E-102.
3. Electrical single line, schematic diagrams, and conductor connection diagram.
4. Layout drawings indicating arrangement, dimensions, cable entries, and weights.

5. Manufacturer's product and catalog data indicating equipment specifications and features including interrupting, withstand, and continuous current ratings of all relevant equipment and components. Catalog data shall be edited or “arrowhead” to indicate only the models and options to be provided as part of this specification.
6. Manufacturer’s procedure for ground-fault performance test.
7. Structural Bracing and Anchorage, Intake PS and LeChee WTP:
    a. Manufacturer’s written certification confirming that the equipment bracing complies with the specified requirements.
    b. Manufacturer’s scaled drawings for the equipment showing internal assembly bracing.
    c. Weight for each complete equipment assembly.
    d. Manufacturer’s recommended anchorage requirements in accordance with the specified requirements, if available from the manufacturer.

D. Informational Submittals – Power Utility:
1. The SES submittal information shall also be submitted to Power Utility Metering Department for their approval. Separate submittals for each of the Intake PS, LeChee WTP, and the LeChee PS No. 3. Combined submittal is not acceptable.
2. After Power Utility approval, submit one approved copy with Utility comments to the Owner.

E. Closeout Submittals – Operation and Maintenance (O&M):
1. Applicable O&M information on an item-by-item basis in accordance with Section 01 78 23.
2. Include the following in each O&M manual:
    a. Final reviewed submittals, including revised as-built drawings.
    b. Manufacturer’s O&M instructions, edited for this project.

1.04 PROJECT / SITE CONDITIONS

A. The equipment shall be designed and manufactured to meet the specified requirements of Sections 01 11 80 and 01 73 24 for environmental and seismic conditions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer’s products, nor shall it be construed that named manufacturers’ standard equipment or products will comply with the requirements of this Section. Candidate manufacturers include:
1. Eaton Cutler-Hammer.
2. Square D.

2.02 SERVICE ENTRANCE SECTION

A. General:
   1. Coordinate with Power Utility for the correct meter socket, test devices, potential transformers, current transformers, and other items installed in the metering section. Refer to Power Utility Electric Service Requirements, latest edition.
   2. Equipment and materials shall be new and free from defects.
   3. Continuous Current Ratings: Refer to Drawings.

B. Power Disconnect - Circuit Breaker Type:
   1. The circuit breaker with adjustable solid-state trip with sizes as indicated. The circuit breaker settings shall be confirmed with a protective device coordination study provided by others.
      a. General:
         1) Circuit breakers shall be stored energy type mechanism to provide quick-make, quick-break, trip-free operation:
            a) Insulated case UL listed 100 percent continuous current capacity.
            b) Ground fault protection shall be provided as specified or indicated.
      b. Circuit breakers shall provide manual switching operation by means of a low-torque handle or pushbutton on the front of the unit. Automatic operation during overload and short circuit conditions shall be provided by solid state or thermal magnetic tripping devices located in the circuit breaker frame as specified on the Drawings.
      c. Circuit breakers shall be front accessible, stationary, individually mounted, and shall have short circuit capabilities equal to or greater than the system in which they are installed. Unless otherwise noted, circuit breakers shall have a minimum interrupting current of 65,000 amperes symmetrical Root-Mean-Square (RMS) at 480 Vac.
      d. Static Tripping Devices:
         1) Solid state static tripping devices shall consist of current sensors, logic assembly, magnetic latch release, and required interconnecting wiring. Tripping devices shall be automatic and self-contained within the breaker frame and shall not require any external relaying or power supplies.
      e. Tripping functions shall be field adjustable and contain the following tripping characteristics:
         1) Overload tripping:
            a) Adjustable ampere setting
            b) Adjustable long-time delay
         2) Short circuit tripping:
            a) Adjustable short-time pickup
            b) Adjustable short-time delay
            c) Adjustable instantaneous pickup
         3) Ground fault tripping:
            a) Adjustable ground fault pickup
            b) Adjustable ground fault delay

2. Power Bus:
    a. The bus shall be insulated tin-plated copper bus bar. Unless otherwise specified, buses shall be braced to withstand short circuit stresses up to 65,000 RMS amperes.
3. Enclosure:
    a. The enclosure shall be designed for outdoor installation. Each of the enclosure sections shall have a full-length flanged front door.
    b. The structure supporting current carrying parts shall be flame retardant non-tracking glass polyester or porcelain.
4. Safety Interlocking:
    a. The inner door shall be hinged and interlocked with the main circuit breaker so that the power disconnecting device opens before internal access is possible and the door must be closed before the power disconnecting device may be closed.
5. Surge Protective Device:
    a. Refer to Section 26 43 13. Provide a transient voltage surge suppressor (TVSS) rated at:
        1) 480Y/277 Vac
        2) 150,000 ampere per phase with 5-nanosecond response time
        3) Five-year manufacturer warrantee with UL Label.
        4) Features:
            a) Fault monitoring dry contact output.
            b) Strike counter.
6. Grounding:
    a. A common ground bus shall extend the entire length of the assembly with ground lugs furnished at each end where multiple enclosures are attached together. A ground lug, sized for a 4/0 bare copper ground wire shall be bolted to the interior of the enclosure.
7. Neutral:
    a. A neutral bus shall extend the entire length of the assembly with lugs furnished at each end where multiple cabinet enclosures are attached together.
8. Finish:
    a. The finish shall be Manufacturer’s standard.
9. Nameplates:
    a. In addition to the manufacturer's identification, an external nameplate shall be provided with equipment number and name as shown.
    b. Each section compartment shall be provided with nameplates indicating utility meter, main breaker circuit name with equipment number and description of load, pull sections, SPD, and any additional designations describing the compartment function or usage.
    c. Provide machine-engraved laminated black phenolic nameplates with white lettering for panel-mounted equipment with the instrument tag number/description in 3/32-inch minimum size lettering and attach to the panel or enclosure with a minimum of two self-tapping 316 stainless steel screws. Provide nameplates for power sources indicating the power loads and nameplates for power loads that indicate the power sources, in accordance with these specifications and the NEC.

10. Wiring:
    a. Internal switchboard wiring shall consist of single conductor SIS 90 degree C copper wire and UL listed for panel wiring. The wire shall be sized to suit load requirements. Minimum size shall be No. 14 AWG.
11. Structural Bracing:
    a. Assembly shall be braced by the manufacturer per the seismic requirements of the Structural Drawings and Specifications. Submit bracing information.

PART 3 EXECUTION

3.01 INSTALLATION AND INSPECTION

A. Coordinate the SES conduit installation with the power utility and request their inspection of the work prior to covering up the work.

3.02 PROTECTIVE DEVICE SETTING COORDINATION

A. Refer to Section 26 05 74 for Short Circuit and Protective Device Coordination Studies and Section 26 08 00 for device setting implementation requirements and Arc Flash labeling requirements.

3.03 PROTECTIVE DEVICE SETTINGS

A. The power utility metering instrument transformer ratios shall be confirmed with the power utility metering department.

B. The protective devices shown on the drawings are preliminary and are subject to confirmation with the coordination study in Section 26 05 74.

C. The ground fault protective device and the fuses or tripping devices shall be adjusted to the settings specified in the protective device coordination study in Section 26 05 74 prior to energizing the SES.

3.04 FIELD TESTING

A. The SES equipment shall be tested in accordance with Section 26 08 00. Verify the ground fault setting and trip functions. Perform ground-fault protection performance test per Manufacturer instructions. Provide written successful test results.

END OF SECTION

SECTION 26 22 00

LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies dry-type transformers with primary winding rated 600 volts and less used for power distribution, lighting and control purposes as specified or shown.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/IEEE C57.12.01	General Requirements for Dry-Type Distribution and Power Transformers
ANSI/UL 506	Specialty Transformers
DOE	10 CFR Part 431 Efficiency Standards
NEMA ST20	Dry-Type Transformers for General Application

1.03 RATINGS AND STANDARDS

A. Transformers rated:
   1. Voltage, frequency, number of phases and kVA as indicated.
   2. Conform to American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE) C57.12.01, Department of Energy (DOE) 10 CFR Part 431 Efficiency Standards, National Electrical Manufacturers Association (NEMA) ST20, and ANSI/ UL (Underwriters Laboratories) 506.

1.04 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 00:

B. Action Submittals – Product Literature:
   1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. Manufacturer's product literature.
   3. Dimension and rating data.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section. Candidate manufacturers include:
   1. Eaton.
   2. Schneider – Square D.

2.02 INSULATION

A. Transformers temperature rise based on 40-degree C ambient temperature:
   1. Not exceed 80 degree C temperature rise.

2.03 COILS

A. Transformer coils:
   1. Copper.
   2. 15 kVA and above:
      a. Impregnated with varnish.

2.04 WINDING CONFIGURATION

A. Transformers shall have electrically isolated primary and secondary windings. Primary and secondary winding configurations shall be as specified or shown. Provisions shall be made to permit separate grounding of the neutral conductor and the enclosure. Single-phase transformers shall be the four winding type.

2.05 TRANSFORMER TAPS

A. Transformers 15 kVA and above shall be provided with two 2-1/2 percent full capacity taps above normal voltage and four 2-1/2 percent full capacity taps below rated voltage on the primary winding.

2.06 TERMINAL COMPARTMENTS

A. Terminal compartments shall be sized to permit termination of cables specified. Terminal connections shall be made in the bottom third of the enclosure. The terminals shall be copper and sized for the cable specified.

2.07 ENCLOSURES

A. Transformers enclosures:
   1. Indoor:
      a. Dripproof, ventilated enclosures.
   2. Outdoor:
      a. Weatherproof enclosures.

2.08 MOUNTING

A. Transformers 15 kVA and below shall be suitable for wall mounting and include mounting brackets and hardware. Transformers over 15 kVA shall be floor mounting type.

2.09 NAMEPLATES

A. Nameplates shall be provided in accordance with the requirements of Section 26 05 00-2.02.

2.10 SOUND LEVELS

A. The sound levels shall not exceed the following values:

kVA	dB
10 - 50	45

PART 3 EXECUTION

3.01 GENERAL

A. Bond transformer enclosures and neutrals together and connect to the ground grid.

3.02 INSTALLATION

A. Install transformers on walls or floors at locations shown on the Drawings. Install floor mounted transformers on raised concrete bases. Provide sufficient access and working space for ready and safe operation and maintenance.

B. Mount transformers so that vibrations are not transmitted to the structural parts of the building or to other equipment. Make connections to transformers with flexible conduit.

C. Adjust tap settings to provide proper voltage at panelboards.

D. Ground transformer in conformance with the National Electrical Code.

3.03 TESTING

A. Transformers shall be tested in accordance with Section 26 08 00.

END OF SECTION

SECTION 26 24 13

SWITCHBOARDS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies indoor, front accessible, deadfront power distribution switchboards rated 600 volts, 3 phase, 3-wire, 60 Hertz.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI C57.13	Requirements for Instrument Transformers
IEEE	Institute of Electrical and Electronic Engineers
NEMA PB 2	National Electrical Manufacturer Association Deadfront Distribution Switchboards
UL 891	Underwriters Laboratory - Deadfront Switchboards

B. Listed Products: Electrical equipment and materials shall be listed for the purpose per Section 26 05 00.

C. Factory Tests

1. Switchboards shall be tested for operation at the specified voltage and current ratings after assembly. The main circuits shall be given a dielectric test of 2200 volts for 1 minute between live parts and ground, and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500 volts for 1 minute between live parts and ground.
2. Instrument transformers shall have ratio and phase angle tests made in conformance with ANSI C57.13.

1.03 SUBMITTALS

A. The following information shall be submitted in accordance with Sections 01 33 00 and 26 05 00.

B. Provide separate submittals for each of the Intake PS, LeChee WTP, and the LeChee PS No. 3 for the following:

C. Action Submittals –Shop Drawings and Product Literature:

1. A copy of this Specification section, Section 01 73 24, and Section 26 43 13, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. A copy of the following Contract Documents' Electrical Drawings, with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "NO CHANGES REQUIRED." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
    a. Intake PS: S-001, E-103, E-104, and E-105.
    b. LeChee WTP: S-00-001, E-00-131, E-00-501, E-00-502 and I-00-101.
    c. LeChee PS No. 3: S-001, E-101, and E-102.
3. Catalog data on all electrical devices and components mounted on or within the switchboard.
4. Manufacturer's data indicating interrupting, withstand, and continuous current ratings of all relevant equipment and components.
5. Arrangement and layout drawings of the switchboard enclosures indicating equipment and bus arrangement and dimensions including areas of permissible cable entries. A list of material and components shall accompany the layout drawings. Include weight and shipping split data.
6. Submittal requirements of Section 26 43 13.
7. Structural Bracing and Anchorage:
    a. Manufacturer's written certification confirming that the equipment bracing complies with the specified requirements.
    b. Manufacturer's scaled drawings for the equipment showing internal assembly bracing.
    c. Weight for each complete equipment assembly.

d. Manufacturer's recommended anchorage requirements in accordance with the specified requirements, if available from the manufacturer.

D. Closeout Submittals – Operation and Maintenance (O&M):
   1. Applicable O&M information on an item-by-item basis in accordance with Section 01 78 23.
   2. Include the following in each O&M manual:
      a. Final reviewed submittals, including revised as-built drawings.
      b. Manufacturer's O&M instructions, edited for this project.
      c. Written record of menu configuration, jumpers, switch settings, and other configurable parameters for the power quality monitor.

1.04 PROJECT/SITE CONDITIONS

A. Ambient and seismic conditions shall be as specified in Section 26 05 00-1.04.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Switchboards shall be provided in accordance with UL 891, NEMA PB 2, and as specified.

B. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section. Candidate manufacturers include:
   1. Eaton Cutler-Hammer.
   2. Schneider – Square D.

2.02 CONSTRUCTION

A. Arrangement:
   1. Switchboards shall be new, deadfront, indoor type, metal enclosed, self-supporting, and suitable for 600 volts, 3 phase, 3 wire service. Suitable for mounting against a wall without back access.
   2. Switchboards shall be provided with vertical sections bolted together to form rigid units with switching and protective devices of the number, rating, and type specified.
   3. Interconnections, instrumentation, and control wiring shall be completed in the factory so that site work is limited to bolting shipping sections and connecting cable assemblies.

B. Structure: Structural members shall be universal frame die formed type, bolted and braced using self-tapping bolts. Cover plates shall be steel having formed edges. Front plates shall be sectionalized and removable. Lifting eyes shall be provided and switchboards shall be capable of being rolled or moved into position and bolted directly to the floor without the use of floor sills. Switchboard enclosure rating shall be NEMA-1 gasketed.

C. Structural Bracing:
   1. Switchboard assembly shall be braced by the manufacturer per the seismic requirements of Structural Drawings and Specifications. Submit bracing information.

2.03 COMPONENTS

A. Bus Bars:
   1. Buses shall be tin-plated copper of sufficient size to limit the temperature rise to 65 degrees C, based on UL 891.
   2. Unless otherwise specified, buses shall be braced to withstand short circuit stresses up to 65,000 root mean square (RMS) amperes. Main horizontal bus shall be mounted on glass polyester insulators and shall have the continuous capacity specified.
   3. A ground bus having a momentary rating at least equal to the highest momentary rating of any circuit breaker in the assembly shall extend the full length of the switchboard. Ends of the ground bus shall be provided with clamp-type terminals for No. 4/0 American Wire Gauge (AWG) bare copper grounding conductors.

B. Circuit Breakers:
   1. General: Circuit breakers shall be stored energy type mechanism to provide quick-make, quick-break, trip-free operation:
      a. Main: Insulated or molded case UL listed 100 percent continuous current capacity.
      b. Molded case UL listed 80 percent continuous current capacity.
      c. Ground fault protection shall be provided as specified or indicated.
   2. Circuit breakers shall provide manual switching operation by means of a low-torque handle or pushbutton on the front of the unit. Automatic operation during overload and short circuit conditions shall be provided by solid state or thermal magnetic tripping devices located in the circuit breaker frame as specified on the drawings.
   3. Circuit breakers shall be front accessible, stationary, individually mounted, and shall have short circuit capabilities equal to or greater than the system in which they are installed.
   4. Circuit breakers shall have a minimum interrupting current of 65,000 amperes symmetrical RMS at 480 Vac.
   5. Static Tripping Devices: Solid state static tripping devices shall consist of current sensors, logic assembly, magnetic latch release, and required interconnecting wiring. Tripping devices shall be automatic and self-contained within the breaker frame and shall not require any external relaying or power supplies.
      a. Tripping functions shall be field adjustable and contain the following tripping characteristics:
         1) Overload tripping:
            a) Adjustable ampere setting
            b) Adjustable long-time delay
         2) Short circuit tripping:
            a) Adjustable short-time pickup
            b) Adjustable short-time delay
            c) Adjustable instantaneous pickup

3) Ground fault tripping:
   a) Adjustable ground fault pickup
   b) Adjustable ground fault delay

C. Panel Instruments and Accessories:
   1. Current transformer accuracies shall conform to ANSI C37.13.
   2. Power Quality Monitor combination units shall have harmonic analyzer ability that displays the voltage/current harmonic and the total harmonic distortion for the electrical equipment being monitored. .
      a. Power Monitor to include 480- to 120-Vac power supply or transformer and fusing to the bus.
      b. Power Monitors shall have the following analog 4-20 mAdc outputs:
         1) Phase-Phase Voltage.
         2) Average Current.
         3) Power Factor.

D. Nameplates:
   1. In addition to the manufacturer's identification, switchboards shall be provided with black phenolic nameplates indicating switchboard, main breaker, and feeder breaker designations as specified. Nameplates shall comply with Section 26 05 00 and the National Electric Code (NEC) for uniquely labeling the power loads and using equipment Tag Numbers and Tag Descriptions where shown on the drawings or schedules.

E. Conductor Markers:
   1. Conductor markers shall comply with Section 26 05 00.

F. Wiring:
   1. Internal switchboard wiring shall consist of single conductor SIS 90 degree C copper wire and UL listed for panel wiring. The wire shall be sized to suit load requirements. Minimum size shall be No. 14 AWG.

PART 3 EXECUTION

3.01 PROTECTIVE DEVICE SETTINGS

A. The protective relays and static tripping devices shall be adjusted to the settings specified in the protective device coordination study in Section 26 05 74 prior to energizing the switchboard.

B. The instrument transformer ratios and protective devices shown on the drawings are preliminary and are subject to confirmation with the coordination study in Section 26 05 74.

3.02 FIELD TEST

A. Each switchboard breaker shall be tested in accordance with Section 26 08 00.

B. Switchboard manufacturer or its authorized personnel shall provide one man-day of on-site configuration and testing for the power quality monitor.
   1. All power monitor jumper, switch, and parameter settings shall be recorded and provided in the O&M Manuals.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 GENERAL

1.01 DESCRIPTION

A. Three phase, four wire 208Y/120 or 480Y/277 volt, dead front, circuit breaker type panelboard with current rating of 600-amperes or less.

B. Single phase, three wire 120/240 volt, dead front, circuit breaker type panelboards with current rating of 400-amperes or less.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEEE	Institute of Electrical and Electronic Engineers
NEMA	National Electrical Manufacturing Association
NFPA 70	National Electrical Code (NEC)
UL 50	Cabinets and Boxes
UL 67	Underwriters Laboratories, Electric Panelboards
UL 489	Molded-Case Circuit Breakers and Circuit Breaker Enclosures
UL 1449	Surge Suppression Devices

1.03 SUBMITTALS

A. The following information shall be submitted in accordance with Sections 01 33 00 and 26 05 00.

B. Provide separate submittals for each of the Intake PS, LeChee WTP, and the LeChee PS No. 3 for the following:

C. Action Submittals –Shop Drawings and Product Literature:

1. A copy of this Specification section, and Section 26 43 13, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. A copy of the following Contract Documents' Electrical Drawings, with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "NO CHANGES REQUIRED." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
    a. Intake PS: E-103, E-104, and E-105.
    b. LeChee WTP: E-00-131, E-00-501, E-00-701, and I-00-101.
    c. LeChee PS No. 3: E-101, and E-102.
3. Manufacturer's product literature.
4. Manufacturer's data indicating interrupting, withstand, and continuous current ratings of all relevant equipment and components.
5. Arrangement and layout drawings of the panelboard.
6. Submittal requirements of Section 26 43 13.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section. Candidate manufacturers include:

1. Eaton Cutler-Hammer:
    a. PRL1a and PRL3a and Clipper Power Visor Surge Protective Device series.
2. Square D:
    a. NQOD and NF with internal Surge Protective Devices.

2.02 ARRANGEMENT AND CONSTRUCTION

A. The front of the panel shall have concealed trim clamps and hinges. The locks shall be flush with cylinder tumbler-type with spring loaded door pulls. The fronts shall not be removable with doors in the locked position. Panelboard locks shall be keyed alike.

B. Gutter space shall be provided on all sides of the breaker assembly to neatly connect and arrange incoming wiring.

C. Panelboard shall be composed of individually mounted circuit breakers designed to be removable without disturbing other breakers.

D. A directory holder with clear plastic plate and metal frame shall be mounted on the inside of the door.

2.03 BUS

A. Bus shall be tin-plated copper for the WTP, bare copper for other sites. Bus shall have current ratings as shown on the panelboard schedules, sized in accordance with UL 67. Ratings shall be determined by temperature rise test.

B. Panel fault withstand rating shall be not less than the interrupting rating of the smallest circuit breaker in the panel. Series rating is prohibited.

C. Panelboards shall be provided with a separate ground bus and, where specified, with a full capacity neutral bus. The neutral bus shall be mounted on insulated stand-offs.

2.04 CIRCUIT BREAKERS

A. Circuit breakers shall be molded-case type provided for the current ratings and pole configurations specified on the panelboard schedule. Circuit breakers shall be bolt-on type. Circuit breakers shall be listed in accordance with UL 489 for the service specified. Load terminals of circuit breakers shall be solderless connectors.

B. Circuit breakers rated 120/208 volt and 120/240 volt alternating current shall have a minimum interrupting current rating of amperes as specified in panel schedules, symmetrical at 240 volt AC.

C. Circuit breakers rated 277/480 volt alternating current shall have a minimum interrupting current rating of amperes as specified in panel schedules symmetrical at 480 volt or as specified on the panelboard schedule.

D. Provide circuit breakers with special features such as ground fault interrupting (GFI), heating air conditioning and refrigeration (HACR) rating, or locking capability as shown on the Drawings or Schedules.

2.05 FINISH

A. Panelboard cabinet shall be fabricated from hot-dip galvanized steel in accordance with UL 50. Panelboard fronts shall have a gray, baked enamel finish.

2.06 SURGE PROTECTIVE DEVICE

A. Provide internal to the panelboard, per Section 26 43 13.

B. Provide circuit breaker sized per the SPD manufacturer.

2.07 NAMEPLATES

A. Nameplates shall be provided in accordance with the requirements of Section 26 05 00.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall type in the circuit description on the circuit directory as shown on the final record drawings or panelboard schedule.

B. Provide “Circuit Directory and Circuit Identification” in accordance with NEC 408.4. Each circuit shall be of sufficient detail to allow each circuit to be distinguished from other circuits. Circuit identification shall include load location and provide equipment or instrument Tag Number and Tag Description, where shown on the drawings.

3.02 TESTING

A. Panelboards shall be tested for proper operation and function.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section specifies wiring devices consisting of receptacles, plugs, switches and appurtenances.

1.02 REFERENCES

A. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NEMA WD-1	General Requirements for Wiring Devices
NFPA 70	National Electrical Code (NEC)

1.03 SUBMITTALS

A. The following information shall be submitted in accordance with Sections 01 33 00 and 26 05 00.

B. Provide separate submittals for each of the Intake PS, LeChee WTP, and the LeChee PS No. 3 for the following:

C. Action Submittals – Shop Drawings and Product Literature:
   1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. Manufacturer's descriptive literature for materials.

PART 2 PRODUCTS

2.01 GENERAL

A. Wiring devices shall be UL approved for the current and voltage specified and shall comply with NEMA WD-1. Devices shall contain provisions for back wiring and side wiring with captive binding screws.

B. Provide devices colored to conform to manufacturer's or industry standard for special use such as orange for isolated ground receptacles, blue for surge suppression receptacles, and red for emergency power receptacles. Unless shown otherwise on the Drawings or Schedules, normal use devices shall be brown, except those located in finished areas shall be ivory.

2.02 RECEPTACLES AND PLUGS

A. General:
   1. Receptacles shall be grounding type.

B. 120V Receptacles:
   1. Indoor, Clean Areas:
      a. Unless shown otherwise on the Drawings or Schedules, receptacles shall be duplex 20 amp, NEMA 5-20R, and shall accept NEMA 5-15P and 5-20P plugs. Where the manufacturer of cord connected equipment requires and isolated ground, a receptacle with isolated ground shall be provided.
         1) Manufacturers: Hubbell 5362, 5362-AI or equal.
         2) Isolated ground receptacle manufacturers: Hubbell IG-5362, Arrow-Hart IG5362, or equal.

2. Outdoor, Process or Corrosive Areas:
    a. Receptacle shall be duplex, 20 ampere, NEMA 5-20R, and shall accept NEMA 5-15P and 5-20P plugs. Receptacle and plug shall be corrosion resistant, marine duty with yellow polycarbonate weatherproof lift covers that maintain weatherprofing during receptacle use.
        1) Manufacturers: Hubbell 53CM62/53CM21, 15W33W/O BOX, or equal.

C. Three Phase Receptacles and Plugs:
    1. Receptacles shall be suitable for 480 volt, 3-phase, 4-wire service, with ampere ratings as specified. Receptacles and plugs shall be designed so that the grounding pole is permanently connected to the housing. The grounding pole shall make contact before the line poles are engaged when the plug is connected to the receptacle housing. The plug sleeve shall also make contact with the receptacle housing before the line and load poles make contact. Receptacles shall be provided complete with cast back box, angle adapter, gaskets, and a gasketed screw-type, weathertight cap with chain fastener. Each receptacle shall be provided with one plug.
    2. Manufacturers:
        a. Crouse-Hinds "Arktite," Appleton "Powertite," or equal.

2.03 SWITCHES

A. General Purpose (Indoor, Clean Areas):
    1. General purpose switches shall be quiet AC type, specification grade, back and side wired, and shall be provided in accordance with rated capacities as required or as indicated on Drawings or Schedules. Switches shall match receptacles in color.
    2. Manufacturers:
        a. General Electric, Hubbell, or Construction Manager accepted substitute , as follows:

	20A, 120-277V	
	G.E. Co.	Hubbell
Single:	PS 20AC1	HBL1221
Three-way:	PS 20AC3	HBL1223
Four-way:	PS 20AC4	HBL1224
SPST momentary:	--	--

B. Switches for Outdoor, Process, and Corrosive Areas:
    1. Switches shall be 20-ampere with weatherproof/ corrosion resistant neoprene plate. Switches shall be mounted in "FS" type copper-free aluminum or PVC mounting boxes.
    2. Manufacturers:
        a. Hubbell or Arrow-Hart as follows:

	Hubbell with 17CM50 plate	Arrow-Hart with 2881 plate
Single pole	1281	2991
Double pole	1282	2992

	Hubbell with 17CM50 plate	Arrow-Hart with 2881 plate
3-way	1283	2993
4-way	1284	2994

2.04 DEVICE PLATES

A. Device plates shall be provided with switches. In non-corrosive indoor areas, receptacle device plates shall be made of sheet steel, zinc electroplated with chrome finish as manufactured by Crouse-Hinds, Appleton, or equal.

B. Device plates in corrosive or outdoor areas shall be corrosion-resistant/marine-duty type. Device plates for explosion-proof equipment shall be factory provided with the equipment.

C. Device plates shall be provided with engraved laminated phenolic nameplates with 1/8-inch white characters on black background.

D. Nameplates for switches shall identify panel and circuit number and area served. Nameplates for receptacles shall identify circuit and voltage if other than 120 volts, single phase.

PART 3 EXECUTION

3.01 INSTALLATION

A. Boxes shall be independently supported by brackets, and expansion bolts as specified. Wooden plugs inserted in masonry or concrete shall not be used as a base to secure boxes, nor shall welding or brazing be used for attachment.

B. Receptacles and switches installed in sheet steel boxes shall be flush mounted. Flush mounted receptacles shall be located 18 inches above the floor unless otherwise indicated. Switch boxes shall be mounted 48 inches above the floor. Receptacles installed in cast device boxes shall be located 48 inches above the floor.

C. Wiring devices shall be tested for correct connections.

END OF SECTION

SECTION 26 29 13

ENCLOSED CONTROLLERS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies individual motor starters and motor controllers installed in enclosures. Refer to drawings for product, device, and circuit requirements.

B. Controller Schedule:

Equipment Name & Tag Number	Controller Number	Driven Equipment Specification	Enclosure Type	E-Dwgs / Notes
Chlorine Booster Pump 1 P2421 (Typ. Pump 2 & 3)	MCP2421	43 23 92.02	NEMA-4X Non-metallic	E-00-131, E-00-501, E-00-522
Decant Pump 1 P4050 (Typ. Pump 2)	MCP4050	43 23 80.12	NEMA-4X SS	E-00-331, E-00-502, E-00-523
Plate Settler Feed Pump 1 P7011 (Typ. Pump 2)	MCP7011	43 23 80.12	NEMA-4X SS	E-00-341, E-00-502, E-00-523
Settled Backwash Solids Pump 1 P7021 (Typ. Pump 2)	MCP7021	43 23 80.12	NEMA-4X SS	E-00-341, E-00-502, E-00-523
Recycled Backwash Water Pump 1 P7031 (Typ. Pump 2)	MCP7031	43 23 80.12	NEMA-4X SS	E-00-341, E-00-501, E-00-523
Process Area Exhaust Fan 1 EF2002 (Typ. Fan 2)	MCP2002	23 34 23	NEMA-4X SS	E-00-131, E-00-701, E-00-522

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid or on the effective date of the Agreement if there were no Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NEMA ICS 1	National Electrical Manufacturer Association General Standards for Industrial Control and Systems
NEMA 250	Enclosures for Electrical Equipment

1.03 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 00 and 26 05 00:

B. Provide separate submittals for each of the Intake PS and LeChee WTP for the following:

C. Action Submittals –Shop Drawings and Product Literature:

1. Submit after driven equipment specification equipment as been submitted or with driven equipment submittal, coordinate motor starter size with motor.
2. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
3. A copy of the following Contract Documents' Electrical Drawings, with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "NO CHANGES REQUIRED." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
    a. LeChee WTP: E-00-311, E-00-341, E-00-501, E-00-502, E-00-522, E-00-523, I-24-102, I-40-104, I-70-101, I-70-102 and I-70-103.

4. Product literature for components to be provided. Literature shall include technical specifications, ratings, range, weight, accuracy, etc. Literature shall be edited to show only items, model numbers, and information which apply.
5. Verification of fault withstand ratings, as applicable, and interrupting ratings.
6. The bill-of-material, schematic diagram, and wiring diagrams.
7. Submittal requirements of Section 26 09 16.
8. Nameplate engraving schedule.

D. Closeout Submittals – Operation and Maintenance (O&M):
1. Applicable O&M information on an item-by-item basis in accordance with Section 01 78 23.
2. Include the following in each O&M manual:
a. Final reviewed submittals, including revised as-built drawings.
b. Manufacturer's O&M instructions, edited for this project.

PART 2 PRODUCTS

2.01 ENCLOSURE

A. The door to the motor starter enclosure shall be interlocked with an externally operated disconnect handle. Disconnect handle shall be arranged to indicate disconnect position. The disconnect operator handle shall have provisions to accept up to three 3/8-inch shackle padlocks to lock the disconnect in the open position.

E. Enclosures shall be:
1. NEMA 12 for indoor areas.
2. NEMA 4 for outdoor areas and WTP process areas.
3. NEMA 4X non-metallic in WTP chlorine storage areas.

2.02 MOTOR BRANCH CIRCUIT PROTECTION

A. General:
1. Motor branch circuit protection shall be provided by fused disconnect switches or molded case motor circuit protectors as specified or as indicated.

B. Molded Case Motor Circuit Protectors:
1. The motor circuit protector (MCP) type molded case circuit breaker shall only be used as a part of a combination motor starter.
2. The MCP shall operate on the magnetic principle with a current sensing coil in each of the three poles to provide an instantaneous trip for short circuit protection. The trip setting shall be adjustable over a range of 700 to 1300 percent of the full load current of the motor served and shall be adjustable from the front of the breaker.
3. The MCP circuit breaker shall be rated to interrupt 22,000 ampere symmetrical when used in conjunction with an individual motor starter.

2.03 MOTOR STARTERS

A. The basic full voltage, non-reversing motor starter (FVNR) shall consist of a 3 pole, 600 volt AC contactor, transient surge suppressor, and solid-state overload relay, NEMA Size-1 minimum.

B. The contactors shall comply with NEMA ICS and NEMA rated for the horsepower as specified.

F. Overload relays shall be adjustable solid-state with protection for each of the poles. An overload condition shall cause the overload relay to latch in the open position. Reset shall be accomplished with a reset button located on the unit door exterior. Trip setting shall be adjustable from 85 to 115 percent of rating. Provide 1 Form C 2-ampere auxiliary contact for remote monitoring of the overload alarm condition.

2.04 TERMINAL BLOCKS

A. Terminal blocks shall be heavy duty, rated at 20 amperes, 600 volts, and shall contain integral marking strips.

B. Terminal blocks shall be provided for external control connections. Spare terminals shall be provided as specified. Terminals shall be permanently identified with the numbers specified.

2.05 CONTROL DEVICES

A. Combination starters shall be provided with door-mounted control devices as shown on the diagrams. Control devices shall be as specified in Section 26 09 16.

2.06 SURGE PROTECTION DEVICE

A. Surge protection devices shall be provided in each starter. Suppressors shall be encapsulated, three component, solid-state circuit, in a module suitable for mounting directly to the starter coil. Additional space for suppressors shall not be required. Suppressors shall be rated 120 volts AC/DC.

2.07 CONTROL CIRCUIT TRANSFORMERS

A. Each combination motor control unit shall be provided with a control circuit transformer rated for 480 x 240-120V, single phase, 60 Hertz. Unless otherwise specified, transformers shall have a minimum volt-ampere rating as follows:

Starter	CPT Minimum Volt-Ampere Rating
Size 1	100
Size 2	150
Size 3	200

B. The transformer size shall be increased if the devices applied will cause a control transformer overload or secondary terminal voltage to drop to or below 95 percent of rated secondary control voltage when rated primary voltage is applied. Each control transformer shall be mounted within the enclosure along with its associated circuit breaker and starter.

2.08 CONTROL CIRCUIT FUSING

G. Two primary fuses, rated to interrupt 200,000 amperes at 600 volts, shall be provided on all motor starters.

H. Each control circuit transformer shall be provided with one control circuit secondary fuse. The secondary fuse shall have an interrupting rating of 10,000 amperes at 250 volts. The secondary fuse shall be sized at 125 percent of full load current. Fuses shall have time delay characteristics as required to prevent false tripping due to coil in-rush currents.

2.09 WIRING

A. Conductors shall be 90-degree C switchboard type. Conductors shall be identified with tag numbers as specified in Section 26 05 00.

2.10 MANUAL STARTERS

A. Manual starters shall comprise a horsepower rated quick-make, quick-break, toggle mechanism together with overloads in all phase conductors.

2.11 NAMEPLATES

A. Nameplates shall be provided in accordance with the requirements of 26 05 00.

2.12 SPARE PARTS

A. The following spare parts shall be provided:
   1. 1--set each fuse size and type for power and control.

PART 3 EXECUTION

3.01 DEVICE CALIBRATION AND TESTING

A. Size the overload relay heater elements or adjust the solid-state overload device to the actual nameplate full load amperes of the motor connected to the starter.

B. Adjust motor circuit protector to the lowest setting not causing false tripping.

C. Record the settings on each motor controller and record the settings as part of the As-Built drawing submittal.

3.02 MOUNTING HEIGHT

A. The Contractor shall mount local motor starters at 48 inches above the floor.

3.03 TESTING

A. Local motor starters and circuits shall be tested in accordance with Section 26 08 00.

END OF SECTION

SECTION 26 29 23

VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies 480 Vac rated adjustable frequency drive motor controller systems using insulated gate bipolar transistors (IGBT) for pulse width modulation technology (PWM).
   2. The AFDs specified in this section shall be the product of a single vendor and mounted in the specified cabinet enclosure.
   3. The terms AFD (adjustable frequency drive), ASD (adjustable speed drive), VFD (variable frequency drive), and VSD (variable speed drive) are interchangeable for the purposes of this specification.
   4. Refer to the drawings for control and monitoring requirements including special interlocking requirements

B. System Requirements:
   1. The AFD system shall convert 460 volt, 60-Hertz nominal input to a suitable voltage and frequency to cause a premium efficient, inverter duty, squirrel-cage induction motor to run at a speed proportional to an external input analog 4 to 20 mA (milliamps) DC for the required AFD speed range.
   2. The AFD system shall include rectifier units, inverter units, control circuitry, protective equipment, input line reactors and output load reactors and other filters and accessories as necessary to provide the specified functions to meet voltage and current harmonics at the specified point of common connection and to mitigate the motor reflected voltage wave. Unless otherwise specified, the point of common connection for AFDs shall be the 480 distribution bus (motor control center, distribution panel, etc.) immediately upstream of the AFD.
   3. The AFD system torque requirement shall match the pump torque requirement. Verify the pump type and select variable torque (VT) or constant torque (CT) as specified in the AFD Schedule.

C. AFD Schedule:

Equipment Name & Tag Number	Drive Number	Drive Horse Power	Drive Speed Range*	Driven Equipment Specification	AFD Type	AFD Enclosure & Mounting	Distance (ft) from AFD to Driven Equipment Motor
Intake Stage 1 Pump A PMP-110 (Typ. Stage 1 Pump B PMP-120/ VFD-120)	VFD-110	75	900-1800	Provided under Section 42 23 71	VT 6P	NEMA-1 Gasketed, Floor Mount	400
Intake Stage 2 Pump A PMP-210 (Typ. Stage 2 Pump B PMP-220/ VFD-220)	VFD-210	150	1800-3600	Provided under Section 43 23 92.01	VT 6P	NEMA-1 Gasketed, Floor Mount	400
Raw Water Feed Pump 1 P2110 (Typ. Pumps 2 and 3)	VFD2110	50	900-1800	43 23 89.13	VT 6P	NEMA-1 Gasketed, Floor Mount	100
Membrane Backwash Pump 1 P2241 (Typ. Pump 2)	VFD2241	30	900-1800	43 23 92 WTP	VT 6P	NEMA-1 Gasketed, Floor Mount	100
Clean-In-Place Pump 1 P2251 (Typ. Pump 2)	VFD2251	20	900-1800	43 23 92 WTP	VT 6P	NEMA-1 Gasketed, Floor Mount	100
GAC Backwash Pump P2300	VFD2300	30	900-1800	46 61 16	VT 6P	NEMA-1 Gasketed, Floor Mount	100
Air Scour Blower 1 P2271 (Typ. Blower 2)	VFD2271	15	900-1800	43 11 33	VT 6P	NEMA-1 Gasketed, Floor Mount	100

*Verify minimum speed range with Engineer based on final review submittals prior to VFD on-site configuration and testing.

D. Environmental Conditions:
   1. Ambient conditions are specified in Section 26 05 00.

E. Seismic:
   1. Freestanding AFDs shall be braced per Section 01 73 24 and Structural Drawings.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEEE 519	IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power System
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 2	Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts
NEMA ICS 6	Industrial Control and Systems: Enclosures
NEMA ICS 7	Industrial Control and Systems: Adjustable-Speed Drives
NEMA ICS 7.1	Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems
NFPA 70	National Electrical Code (NEC)
UL Standard 508	Industrial Control Equipment

B. Industry Standards:

1. The AFD shall be UL 508 listed and shall conform to the requirements specified in NEMA ICS 2, 6, 7 and 7.1.

C. Unit Responsibility:

1. The Contractor shall assign unit responsibility for the adjustable frequency drives in this section as specified in Section 43 05 11-1.03C Unit Responsibility. The Contractor shall submit letters of certification with the shop drawings from the driven equipment manufacturer stating that they have reviewed each application and that the combination will satisfy the application duties required, for the actual motor sizes required, regardless of deviations from the scheduled "nominal horsepower."

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Sections 01 33 00 and 26 05 00.

B. Provide separate submittals for each of the Intake PS and the LeChee WTP for the following:

C. Action Submittals –Shop Drawings and Product Literature:

1. Submit after driven equipment specification equipment as been submitted or with driven equipment submittal, coordinate VFD size with motor.
2. A copy of this Specification section, and Section 01 73 24, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
3. A copy of the following Contract Documents' Electrical Drawings, with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "NO CHANGES REQUIRED." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review:
    a. Intake PS: S-001, E-108.
    b. LeChee WTP: S-00-001, E-00-131, E-00-501, E-00-502, E-00-521; 522; and 523, I-21-101, I-22-108, I-22-109, I-22-116 and I-23-101.
4. Copy of pump submittal Certificate of Unit Responsibility attesting that the Contractor has assigned, and that the manufacturer accepts, unit responsibility in accordance with the requirements of this Section and Section 43 05 11-1.03C Unit Responsibility. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.
5. Catalog and technical data including outline dimensions, shipping section dimensions, and foundation requirements for all assemblies.
6. Schematic diagrams and wiring connection diagram showing functions and identification of terminals.
7. Voltage and current Total Harmonic Distortion (THD) calculations with line reactors or filter design to mitigate harmonics to meet IEEE-519.
8. Intake PS pump VFDs shall also have load reactors and oversized incoming and outgoing power lugs for larger cables due to long cable runs and associated voltage drop.
9. Structural Bracing and Anchorage:
    a. Manufacturer's written certification confirming that the equipment bracing complies with the specified requirements.
    b. Weight for each complete equipment assembly.

c. Manufacturer's recommended anchorage requirements in accordance with the specified requirements, if available from the manufacturer.

D. Closeout Submittals – Operation and Maintenance (O&M):
   1. Applicable O&M information on an item-by-item basis in accordance with Section 01 78 23.
   2. Include the following in each O&M manual:
      a. Final reviewed submittals, including revised as-built drawings.
      b. Manufacturer's O&M instructions, edited for this project.
      c. Written record of as-built menu configuration, jumpers, switch settings, and other configurable parameters for each drive.

E. Informational Submittal – Installation.
   1. Installation certification Section 43 05 11-Form A as specified in paragraph 3.01.

F. Informational Submittal – Training.
   1. Training certification Section 43 05 11-Form B as specified in paragraph 3.03.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section. AFDs shall be installed in the custom enclosures as specified and Candidate manufacturers include:
   1. Danfoss.
   2. Square D.

2.02 ENCLOSURES

A. Provide AFD in NEMA enclosures, with fan cooling.
   1. General:
      a. Provide enclosures with AFDs and custom control as required for the project and as indicated on the drawings. Each drive shall be designed for stand-alone operation and multiple drives shall not utilize shared components. Review the project site location, elevation, temperature, humidity, plant atmosphere, and load current-torque requirements to size the AFD and its associated enclosure with requirements specified herein and the control and monitoring devices and interlocks as indicated.
      b. Enclosures shall be designed for indoor service. Each AFD system shall be mounted in a NEMA 250 internally force ventilated enclosure with UL approved Class 1 filters on ventilation openings. Enclosures shall be fabricated from 12-gage minimum thickness sheet steel with an interior frame or formed to provide a rigid structure.

c. Provide enclosure size to allow entry of power source and motor load cables as indicated on the drawings. Submit drawing of the source and load power cable location within the enclosure and indicated barriers from control and instrument wiring.

d. Door width shall not exceed 30 inches and shall be hung on removable-pin hinges, with three-point latch hardware, and handle latch for 3/8-inch-shackle padlock.

2.03 AFD ASSEMBLIES

A. General:

1. AFDs shall include the following assemblies:
   a. Power disconnect using a thermal magnetic circuit breaker or fused disconnect sized for the specific application by the manufacturer.
   b. Line input harmonic filter for harmonic mitigation.
   c. A load reactor for dV/dT mitigation for addressing dv/dt effects at the motor for the Intake PS VFDs.
   d. Rectifier, direct current bus filter, and inverter.
   e. Control circuitry interface with Operator Interface Unit.
   f. Output protection including phase overload.

B. AFD Features:

1. Provided with the following features:
   a. Fused control circuit transformer and microprocessor for system logic sequencing functions. Provide fuses with blown fuse indicator lamps.
   b. Accept 4 to 20 mAdc input speed reference signal.
   c. A 4 to 20 mAdc output signal proportional to inverter output frequency for the speed range specified.
   d. Adjustable minimum/maximum frequency limits:
      1) Minimum frequency shall be adjustable from 6 to 40 Hertz.
      2) Maximum frequency shall be adjustable from 48 to 90 Hertz.
   e. Adjustable and independent timed linear acceleration and deceleration functions, adjustable from 6 to 20 seconds.
   f. Current limiting.
   g. Automatic restart.
   h. Control Wiring:
      1) 600 volt stranded copper
      2) 90 degrees C color-coded insulation
      3) No. 16 AWG
   i. Wiring Identification and Termination:
      1) Crimp type wire lugs with sleeve type markers at each termination point and numbered terminal blocks for external connections.
   j. Electrically isolated discrete output contacts for signals as specified on P&ID drawings.
   k. Not used.

l. Control Power:
    1) Provide a 120 Vac, triple fused, control power transformer for cooling fans and external control circuits when required. Control circuits shall be isolated from power circuits by distance and by insulated barriers.
m. Provide 120 Vac or 24 Vdc as required for Operator Interface Unit.

C. Functional Requirements:
1. Supply Power:
    a. Operate continuously with supply power of 480 volts plus or minus 10 percent, 60 Hertz plus or minus 3 percent and remain on line and operate without damage to the AFD or connected load during a supply power under-voltage variation to the drive up to 85% of its nominal value for 30 milliseconds at full load.
2. Environmental Conditions:
    a. Ambient temperature:
        1) 0 to + 40 degrees C / 104 degrees F
3. Load:
    a. Capable of driving the specified maximum motor load continuously and under the following conditions:
        1) Deliver 110 percent of the specified load for up to 60 seconds in variable torque applications.
        2) Deliver 150 percent of the specified load for up to 60 seconds in constant torque applications.
4. Efficiency:
    a. Not less than 95 percent at 60 Hertz output driving the specified maximum load at rated torque and speed at 40 degrees C ambient based on measured input power versus output power with all specified components in the system.
5. Frequency and Voltage Regulation:
    a. Output frequency regulated to within 0.6 Hertz of the signal/output frequency relationship. Output voltage regulated to within 1.0 percent to produce minimum motor heating at any operating frequency within the specified range.
6. Frequency Range:
    a. AFD shall be capable of continuous operation with the specified load at any frequency between 6 and 60 Hertz unless noted otherwise.
7. Space and AFD Access:
    a. Enclosure size shall not exceed the size allotments specified on the drawings nor shall any portion of the AFD system exceed a height of 90 inches.
    b. Front accessible only and shall not require rear access.
    c. Mount against the wall without any clearance for ventilation or other purposes.
    d. Submit AFD in the enclosure drawing with the detail of front door and the internal arrangement, including the feeder and motor cables, and the control cables, and the instrument cable location and terminations.
8. Ambient Noise:
    a. Free field noise generated shall not exceed 85 dBA at 3 feet out from any point on the AFD enclosure under any normal operating condition.

9. Not used.

D. Protection and Annunciation:
   1. Overcurrent Protection:
      a. Electronic current limit at 150 percent of motor nameplate current and provide motor running overcurrent protection in compliance with NFPA 70.
   2. Short Circuit Protection:
      a. Protected against load faults: bolted faults, phase to phase or phase to ground shall not damage the unit. Fault protection based on a power source short circuit capacity of 42,000 amperes RMS symmetrical at the AFD power input terminals with impedance or current limiting device provided.
   3. Line Voltage:
      a. Protected against high and low line voltage on one or more phases.
   4. Internal Faults:
      a. Internal fault monitoring system to detect malfunctions to protect from transient and sustained faults and to limit damage that may be caused.
   5. Motor Over Temperature:
      a. Interface to motor over temperature devices as specified .
   6. Fault Alarm:
      a. Indicates the cause of any shutdown visible on the AFD keypad/display without opening the AFD enclosure. As a minimum, the following faults shall be alarmed:
         1) Motor over-temperature
         2) Motor overcurrent
         3) Incoming power line over/under/unbalanced-voltage
         4) AFD over-temperature
         5) AFD over-voltage
         6) AFD control failure
   7. Safety Features:
      a. The AFD shall include:
         1) Padlock main disconnect handle in the “Off” position.
         2) Mechanical interlock to prevent opening enclosure door with disconnect in the “On” position while the unit door is open.
         3) Auxiliary contact on main disconnect to isolate 120Vac control power when fed from external source.
         4) Barriers and warning signs on terminals that are energized with the power disconnect “OFF”.
         5) Separation and insulated barriers between the power and control and instrument products.
         6) External emergency stop input
   8. Reverse Direction Protection:
      a. Provide protection from inadvertent operation in reverse where reverse rotation can damage the driven equipment.

9. Critical Speed Bypass:
    a. Provide capability to program speed bypass for minimum two critical speed points.
10. Transient Voltage Protection:
    a. Provide solid state transient voltage protection to meet or exceed ANSI C37.90.

2.04 CONTROL AND MONITORING DEVICES

A. Front door mounted on the AFD enclosure between 36 inches and 72 inches above the floor for each unit:
    1. Digital Operator keypad/display.
    2. Hand-Off-Auto door mounted selector switch.
    3. Manual speed control: Potentiometer function
    4. Internal terminal strips for remote monitoring:
        a. Run status
        b. Trouble / Fail alarm
        c. Auto Mode status
        d. Additional signals as indicated on the drawings.

B. Operator Interface Unit:
    1. Digital keypad/display for monitoring and controlling the drive and to input drive parameter settings with a backlit LCD or equally visible display with a minimum of 16 characters per line.
    2. Digital keypad for numerical settings in English engineering units and a guide to parameter settings. Setup operations and adjustments stored in non-volatile EEPROM memory transferable to new and spare boards. Settings shall be protected from unauthorized tampering, revision, or adjustment by a personal lockout code.
    3. The digital keypad to provide programming of the drive and include:
        a. Up and Down Arrow Keys:
            1) Increase or decrease output frequency or data values.
        b. Monitor Key:
            1) Selection of control mode.
        c. Run and Stop Keys:
            1) Starting and stopping in the manual mode.
        d. Fault Clear / Enter Keys:
            1) Reset fault conditions and enter chang
        e. Program Key:
            1) Enter the program mode and adjust parameters.
        f. Remote / Local Location Keys:
            1) Operation location and local speed control.
        g. Auto / Manual Mode Keys:
            1) Program mode.
        h. Number Keys:
            1) 0 through 9 keys to access specific parameters.

i. Keypad Digital Illustrations:
   1) English and display the last 5 faults.
j. Frequency / Motor Speed Indication:
   1) Calibrated in Hertz and RPM.
k. Run Status Indication.
l. Ready Status Indication.
m. Fault Alarm Indication.

C. Monitoring Communication:
   1. Modbus TCP/IP EtherNet Communication Card.

2.05 KEYPAD FUNCTIONS AND OPERATION

A. Adjustment of the following parameters through the OIU digital keypad:
   1. Current limit and torque boost.
   2. Maximum voltage level.
   3. Minimum/Maximum speed, Volts/Hertz, Upper and Lower limit.
   4. Adjustable acceleration rate and deceleration rate.
   5. Electronic thermal overload setting.
   6. Coast, controlled ramp or DC injection selectable modes of stopping.
   7. PID setpoint and time-function selection.
   8. Critical frequency avoidance:
      a. Three set points selectable from 0 to maximum frequency with set points adjustable from 0-30 Hertz.

2.06 NAMEPLATES

A. Nameplates shall be provided in accordance with the requirements of Section 26 05 00. Nameplates shall be provided for all drive enclosures. Provide equipment tag numbers and descriptions as shown in paragraph 1.01.C.

2.07 SPARE PARTS

A. The following spare parts shall be supplied with each type or frame size AFD:
   1. Three sets of all replaceable fuses.

PART 3 EXECUTION

3.01 FIELD INSTALLATION

A. Each adjustable speed controller shall be installed and tested by the Contractor with the assistance of factory-trained pump manufacturer engineer/technician and AFD engineer/technician in accordance with the manufacturer's specifications, Section 26 08 00, the associated pump specification, and witnessed by the Construction Manager.

B. Manufacturers' factory representatives shall provide field testing for devices including the setup of the Operator Interface Unit and the setup of the data communication devices, where used. Upon satisfactory completion of the testing, the Contractor shall submit two certified copies of the test report to the Construction Manager.

C. Component failure during testing will require repeating any test associated with the failure or modified components to demonstrate proper operation.

D. The installation shall be certified on Form 43 05 11-A specified in Section 01 99 90.
   1. Adjust drive and perform "start-up" tests as recommended by manufacturer. Set parameters and carrier frequency for existing motors to avoid insulation damage.
   2. Establish proper direction of rotation for the motor controlled by the drive. Verify that the AFD is precluded from operating in a direction that can damage the driven equipment. Change motor or AFD power lead connection and not the AFD direction, where rotation is incorrect.
   3. Verify that the drive will operate properly both in the "manual speed control mode" and in the "remote or automatic mode" from a remote speed signal input.
   4. Set the maximum "locked rotor" current drawn during start-up recommended by the manufacturer and approved by the Construction Manager.
   5. Set the minimum and maximum speeds and the acceleration and deceleration "ramps" recommended by the Construction Manager.
   6. Verify the motor high temperature switch contacts are wired into the AFD 120 Vac control circuit and will trip on high winding temperature. Test or simulated the alarm and trip feature at the motor for high temperature. Test or simulated the alarm and trip feature at the motor for high temperature.
   7. Configure AFD to prevent operation below minimum speed per paragraph 1.01 C in either hand or automatic modes.
   8. Check for excessive heating of the drive and motor. Report any discrepancies to the Construction Manager.

3.02 HARMONIC TESTING

A. The Testing Firm specified in Section 26 08 00 shall perform a harmonics acceptant test with all AFD motor controllers operating to verify compliance with IEEE 519 of less than 5 percent voltage THD and 12 percent current THD at the defined point of common connection when running from Power Utility power source with a BMI-Dranetz or equal harmonic test set that provides a hard-copy record of the test results.

B. The test shall also be run with power sourced from the standby generator where such a power source is being used at the project site. THD shall be limited to a maximum level of 8 percent voltage THD on standby generator operation.

C. Submit the test performance to the Construction Manager per latest version NETA ATS Acceptance Testing Specifications. Refer to the electrical testing specification Section 26 08 00.

3.03 TRAINING

A. Two shifts of two hours of onsite AFD operation and maintenance training shall be provided for the Owner's Operation and Maintenance Staff.

B. Manufacturers' factory representative shall conduct the training, upon acceptance of a resume submitted by the trainer.

C. Training shall be certified on Form 43 05 11-B specified in Section 01 99 90.

END OF SECTION

SECTION 26 32 13.13

DIESEL ENGINE DRIVEN GENERATOR SETS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This Section specifies the requirements for providing, factory testing, and on-site acceptance testing of complete and operable standby diesel engine driven generating system (GenSet). This section covers outdoor diesel engine generator sets with outdoor metal enclosures used only for providing power during a loss of utility power. Equipment provided under this section is not suitable for peak shaving, or any other unrestricted long-term operaton that would have to meet Tier 4 emission standards. This section also inlcudes belly tank fuel storage container, and the devices and equipment required for the system operation.

B. The generation system shall include the following:
   1. Digital control, monitoring, and display system.
   2. Cooling system.
   3. Belly tank.
   4. Exhaust silencer: Mounted inside the enclosure.
   5. Noise dampening mounting system.
   6. Sound attenuated outdoor enclosure.
   7. Accessories:
      a. Batteries.
      b. Battery charger.
      c. Block heater.
   8. Control system testing
   9. Not used.
   10. Testing with load bank.

C. Operating Requirements:
   1. The electric power generating system shall have ratings as indicated with 0.95 power factor, 480 volts, WYE connected generator, three-phase, four-wire, 60-Hertz, 1800 rpm and rated for Standby operation per NEC Article 701.

D. Generator Set Schedule:

Tag No.	Description / Location	Enclosure
GEN001	Standby Diesel Fueled Generator / Next to Intake Control Building	Outdoor
GEN9001	Standby Diesel Fueled Generator / Next to WTP Building	Outdoor

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI C57.13	Requirements for Instrument Transformers
IEC 34-5	International Electrotechnical Commission Rotating Electrical Machines - Part 5: Degrees of Protection by Enclosures for Rotating Machinery
IEC 60529	Degrees of protection provided by enclosures (IP Code)
ISO	International Organization for Standardization
NEMA MG1	Motors and Generators
NEMA MG2	Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators
NEMA SG31	Low Voltage Power Circuit Breakers
NEMA SG51	Power Switchgear Assemblies
NFPA 37	Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 70	National Electrical Code (NEC)
NFPA 110	Standard for Emergency and Standby Power Systems
OSHA	Occupational Safety and Health Administration

Reference	Title
SAE J 1349	Society of Automotive Engineers Engine Power Test Code
UL 142	Underwriters Laboratories Inc., Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids
UL 2200	Underwriters Laboratories Inc. Standard for Safety Stationary Engine Generator Assemblies
UL 2085	Underwriters Laboratories Inc. Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids

B. Unit Responsibility:
   1. The Contractor shall assign unit responsibility, as specified in Section 43 05 11, to the manufacturer of the GenSet provided under this section. This manufacturer is the unit responsibility manufacturer and has unit responsibility, as specified in Section 43 05 11, for the GenSet equipment assembly specified in this section. A completed, signed, and notarized Certificate of Unit Responsibility (Section 01 99 90-Form 43 05 11-C) shall be provided.

C. Design Requirements:
   1. Engine:
      a. Rating:
         1) Engine brake horsepower shall be sufficient to deliver full rated GenSet kW/kVA when operated at rated rpm and equipped with all engine-mounted parasitic and external loads such as radiator fans, fuel pumps, and cooling water pumps.
      b. Fuel:
         1) Diesel engines shall be able to deliver rated power when operating on ultra low-sulfur No. 2 diesel fuel.
      c. Fuel Consumption:
         1) Diesel fuel rates shall be based on fuel having a low heating value (LHV) of 42,780 kJ/kg (18,390 Btu/lb) when used at 29°C (85°F) and weighing 838.9 g/l (7.001 lb. / U.S. gal).
   2. Generator:
      a. Motor starting:
         1) Solid-state-starters, variable speed controllers, or auto-transformer reduced voltage starting with the typical RVAT start would be on the 65% tap, as indicated.
      b. Generator Performance:
         1) Voltage dip for motor starting shall not exceed 25% for any individual load step.
   3. GENSET Start time and load acceptance:
      a. Engine shall start, achieve rated voltage and frequency, and be capable of accepting load within 10 seconds.
   4. Outdoor Enclosure:
      a. GenSet enclosure shall be designed to resist the loads prescribed by the Governing Building Code including: Dead, Live, Wind, Seismic, Rain, Snow, and Ice.

b. GenSet enclosure shall also be designed to support any superimposed loads imparted from system components mounted to it, including those identified in Section 1.01.B.

c. In no case shall the enclosure be designed to resist loads less than the minimum loading conditions listed below:

1)	Roof live load:	50 psf
2)	Floor live load (when equipped):	200 psf
3)	Wind Load design speed:	100 mph

D. Noise Requirements and Control:

Sound pressure level when operating fully loaded shall not be greater than 75 dBA at 7 meters (23 feet) from the enclosure.

E. Manufacturer's Qualifications and Warranty:

1. The complete power generation system shall be the product of one manufacturer who has been regularly engaged in the production of complete generating systems for at least twenty-five years.
2. The supplier shall be the engine-generating system manufacturer's authorized local representative that shall provide installation assistance, start-up services, and Owner's staff training. The supplier shall have 24-hour service availability with factory-trained technicians qualified to perform trouble-shooting, repairs on the system, and warranty and post warranty -compliance services.
3. Preventive maintenance to be performed by:The GenSet supplier shall provide the following warranty that includes battery warranty:
   a. Two year parts and labor with travel time included.

F. Manufacturer Factory Testing:

1. Functional Tests:
   a. Functional testing of the complete power generation system final assembly shall be performed at the GenSet manufacturer's factory to assure proper system operation.
2. GenSet shall be load tested after the assembly is installed into the enclosure and operate continuously without stoppage for a period of 8 hours.
3. GenSet shall operate for one hour at ½, ¾, and full load, at 0.8 power factor or greater. Restart the test, if stopped for any reason.
4. Prototype Test:
   a. The GenSet manufacturer shall certify that engine, generator, and controls have been tested as complete systems in accordance with NFPA 110 of representative engineering models (not on equipment sold).
5. Sound Test:
   a. Provide a GenSet factory test for sound pressure level measured in accordance with IEEE Standard 85, Test Procedure for Airborne Sound Measurement on rotating electrical machines or propose acceptable alternate to free field sound test. Refer to paragraph 1.02 for sound test criteria.

G. Shipment, Handling, and Storage:
   1. The equipment shall be protected during shipment, handling, and storage per Section 01 66 00.

1.03 ENVIRONMENTAL CONDITIONS

A. General:
   1. The GenSet manufacturer shall verify that the diesel engine is correctly sized and is capable of driving the generator with all accessories in place and operating, at the generator's kW rating after derating for the range of temperatures expected in service and the project site altitude, per NEMA MG1.

B. Seismic:
   1. Equipment and supports shall be braced per Section 01 73 24 and Structural Drawings.

C. Site Conditions:
   1. The site conditions are as specified in Section 26 05 00.

1.04 SUBMITTALS

A. The following submittals shall be provided in accordance with the requirements of Section 01 33 00.

B. Provide separate submittals for each of the Intake PS and the LeChee WTP for the following:

C. Action Submittals – Shop Drawings and Product Literature:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Referenced and applicable sections to be marked up and submitted include:
      a. Section 01 73 24.
   2. A check mark (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. A copy of the Contract Documents' Electrical Drawings, with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "NO CHANGES REQUIRED." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
    a. Intake PS: S-001, E-100, E-104, E-105, and E-106.
    b. LeChee WTP: S-00-001, E-00-101, E-00-501, E-00-701, and I-00-101.
4. Completed Certificate of Unit Responsibility attesting that the Contractor has assigned, and that the manufacturer accepts, unit responsibility in accordance with the requirements of this Section and Section 43 05 11-1.02 Unit Responsibility. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.
5. Manufacturer and manufacturer's type designation.
6. Manufacturer's catalog and/or other data confirming conformance to specific design, material and equipment requirements including:
    a. Engine:
        1) Type, aspiration, compression ratio, and combustion cycle
        2) Bore, stroke, displacement, and number of cylinders
        3) Rotational speed, RPM
        4) Engine lubricating oil capacity
        5) Engine coolant capacity without radiator
        6) Engine coolant capacity with radiator
        7) Coolant pump external resistance (maximum)
        8) Coolant pump flow at maximum external resistance
        9) Exhaust back-pressure (maximum allowable pressure)
        10) Combustion air inlet flow rate
        11) Exhaust gas, flow rate, stack temperature
        12) Exhaust system back pressure (maximum)
        13) Heat rejection to:
            a) coolant
            b) aftercooler
            c) lube oil
            d) exhaust
            e) atmosphere
        14) Fuel Consumption:
            a) 50% load
            b) 75% load
            c) 100% load
        15) Fuel supply system including [belly tank,][day tank,][pump,][and level alarm devices]
    b. Generator:
        1) Model
        2) Frame
        3) Voltage

4) kW
5) Power Factor
6) Frequency
7) Insulation class
8) Number of leads
9) Weight, total
10) Weight, rotor

c. Efficiency At rated voltage:
1) Efficiency at 0.8 power factor for 50% load.
2) Efficiency at 0.8 power factor for 75% load.
3) Efficiency at 0.8 power factor for 100% load.

d. Radiator:
1) Model
2) Type
3) Heat Rejection:
4) BTU/Hour
5) Fan drive ratio
6) Coolant capacity, radiator
7) Coolant capacity, radiator and engine

e. GenSet with enclosure Dimensions:
1) Dimensions:
a) Length, width, height.
2) Weight:
a) Dry and wet.
3) Vibration isolators.

f. Power Rating:

g. Nominal full capacity standby kW at 0.95 power factor and corresponding kVA rating

7. Not used.

8. Structural Bracing and Anchorage:
a. Structural design calculations for the Outdoor Enclosure and Structural Steel Frame supporting the generator, radiator and engine, stamped and signed by a Professional Engineer licensed and registered to practice in Arizona.
b. Manufacturer's written certification confirming that the equipment bracing complies with the specified requirements.
c. Manufacturer's scaled drawings for the equipment showing internal assembly bracing.
d. Weight for each complete equipment assembly.
e. Manufacturer's recommended anchorage requirements in accordance with the specified requirements, if available from the manufacturer.

9. Drawings:
    a. General dimensions drawings showing overall GenSet measurements, mounting location, and interconnection points for load leads, fuel, exhaust, cooling and drain lines.
    b. General dimension drawings for fuel supply and storage system including interconnection points, fuel and drain lines, and level and leak detection equipment, terminal-boxes and panels.
10. Wiring diagrams, schematics and control panel outline drawings published by the manufacturer in Joint Industrial Council (JIC) format for controls and switchgear showing interconnected points and logic diagrams for use by Contractor and Owner.
11. Installation requirements showing clearances required for maintenance purposes: Access to main breaker, oil fill line, fuel fill line, etc.

D. Action Submittals – Contractor-Applied Coatings:
    1. Exterior paint color chip for enclosure per paragraph 3.01.

E. Informational Submittals:
    a. Certified factory test results.

F. Closeout Submittals – Operations and Maintenance (O&M):
    a. Combined O&M for Intake PS and LeChee WTP is not acceptable.
    b. Operation and maintenance information as specified in Section 01 78 23. In addition the following:
        1) Operating instructions with description and illustration of engine and generator controls and monitors.
        2) Manuals that illustrate and list assemblies, subassemblies and components, except the standard fastening hardware.
        3) Preventative maintenance instructions for daily, weekly, monthly, biannual, and annual maintenance requirements. Include a lubrication chart for all components.
        4) Routine test procedures for electronic and electrical circuits including the generator.
        5) Troubleshooting chart covering the complete GenSet with a description of trouble, probable cause, and suggested remedy.
        6) Recommended spare parts list showing consumables anticipated during routine maintenance and test.
        7) Wiring diagrams and schematics showing function of electrical components.
        8) Complete final submittals including As-Built drawings.
        9) Manuals and books described above shall be contained in rigid plastic pouches.
        10) Warranty verification statements published by manufacturer.
        11) Location and description of supplier's parts and service facility including parts inventory and number of qualified GenSet service personnel.

G. Closeout Submittals – Training:
    1. Training certification Section 43 05 11-Form B specified in paragraph 3.03.

H. Closeout Submittals – Field Test Reports:
    1. Field test reports as specified.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Owner and Engineer believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section.

The candidate manufacturers include the following:

Equipment / Manufacturer / Supplier	Engine-Generator
Caterpillar	Caterpillar / Caterpillar
Cummins	Cummins / Onan

2.02 ENGINE EQUIPMENT

A. General:
1. The engine shall be a single stationary, liquid cooled, 1800 rpm, four-cycle design, direct injection engine with forged steel crankshaft and connecting rods. Systems with dual engine-generators will not be permitted.
2. The engine cylinder block shall be cast iron with replaceable wet liners with four valves per cylinder. Provide 6, 12, or 16 cylinders engine with turbocharger and after-cool, as required by the GenSet manufacturer.
3. The GenSet engine shall not be manufactured with any Class I ozone depleting substances (ODS) as defined by Federal Register Vol. 57 No. 86.
4. The GenSet shall be pre-certified EPA Tier-2 emission requirements.

B. Structural Steel Frame:
1. The generator, radiator, and engine shall be securely mounted on a heavy welded steel frame structure frame that is stiffened and cross-braced to provide a rigid mounting base.

C. Engine Equipment:
1. The engine shall be equipped with manufacturers standard air filters, pressure gauges, lubricating oil cooler, filters, and pressure gauge, water pump and temperature gauge, service hour meter, flywheel, and flywheel housing when applicable.
2. Lube Oil Filter:
   a. Provide a lube oil filter, equipped with a spring-loaded bypass valve to ensure oil circulation if filters are clogged.
   b. Provide an oil drip pan for mounting underneath the engine.
   c. Provide an oil drain extension.

D. Engine Fuel System:
   1. Fuel Strainer and Filter:
      a. Provide fuel strainer and filter between engine fuel pump and engine. Provide indicating pressure gauges on both upstream and downstream side of strainer and filter.
   2. Fuel Lines:
      a. Flexible braided stainless steel fuel lines between engine and fuel supply shall be provided to isolate vibration.
   3. Fuel System Maintenance:
      a. The fuel transfer pump, injection pumps, rack and pinion assembly, and timing mechanism shall be maintenance and adjustment free for the life of the equipment. The fuel filter shall not require changing more frequently than once per year or every 250 hours. Provide a fuel filter with spill containment and catch pan for about three gallons of fuel.

E. Governor:
   1. General:
      a. The engine governor shall control engine speed and transient load response. The governor shall be selected, installed, and tested by the GenSet manufacturer.
   2. Speed Control:
      a. The engine governor shall be an electronic speed-control actuator. Speed droop shall be 0 (isochronous) from no load to full rated load.
   3. Frequency Regulation:
      a. The steady state frequency regulation shall be within 0.25%. Speed shall be sensed by a magnetic pickup off the engine flywheel ring gear.
   4. Remote Speed Control:
      a. A provision for remote speed adjustment shall be provided.
   5. Actuator:
      a. The forward acting actuator shall move to the minimum fuel position in the event of a DC power loss.

F. Cooling System:
   1. General:
      a. The engine jacket water cooling system shall be a closed circuit design with provision for filling, expansion, and de-aeration.
         1) The cooling pump shall be driven by the engine. Auxiliary coolant pumps required for heat exchangers or separate circuit after-cooling shall be engine driven.
         2) The cooling system shall tolerate at least 172 kPa (25 psi) static head. Coolant temperature shall be internally regulated to disconnect external cooling systems until operating temperature is achieved.
   2. Engine Mounted Radiator:
      a. Heat rejected to the engine jacket water shall be discharged to the atmosphere through a close-coupled radiator.

3. Coolant:
    a. The unit shall have an antifreeze / coolant mixture. The radiator shall cool the jacket water while the engine is operating at full site capability and 0.123 kPa (0.50 inch water column) external air restrictions.
        1) Additional restriction affecting airflow shall not limit the radiator's capability to adequately cool at maximum site temperature. Provide air flow to meet ambient conditions at specified ratings at 100% rated load.
4. Fan and Belt Guarding:
    a. The fan, fan drive, and fan belts shall be covered with 14 gauge punched steel mesh guarding for personnel protection. The guarding shall conform to IEC 34-5, ISO and OSHA standards.
5. Radiator Fan:
    a. The radiator-cooling fan shall be a propeller type driven from the engine with the air drawn from the engine side and exhausted through the radiator core.
6. Inlet Air System:
    a. The engine air cleaner shall be engine mounted with maintenance access. The maximum restriction to the combustion air inlet shall not exceed engine manufacturer requirements where external ducting provided.

G. Exhaust System:
1. General:
    a. The engine exhaust system shall discharge combustion gases safely and without leakage with minimum restriction. The critical sound silencer shall be designed for minimum restriction without excessive back-pressure.
        1) Engine exhaust piping shall be Schedule 40 carbon steel with long radius 90 degree bends. Piping shall be installed with 9 inch minimum clearance from combustible material or incorporate appropriate insulation and shielding, as appropriate for personnel safety. Provide a stainless steel flexible connection between the engine and exhaust piping.
        2) Exhaust piping shall be supported and anchored to prevent weight or thermal growth being transferred to the engine. Flexible expansion fittings provided to accommodate thermal growth. Support dampers and spring isolators provided to isolate vibration.
        3) Long runs of exhaust piping shall be pitched away from the engine and water traps installed at the lowest point. Provide a 1-inch diameter capped sample port for emissions testing. Provide ports 90-degrees apart on a straight section of exhaust piping.
        4) Exhaust stacks shall be extended to avoid fumes and odors inside enclosure and installed to minimize noise.
2. Silencer:
    a. Exhaust Silencer: The exhaust silencer shall be a critical-grade type exhaust silencer. Exhaust noise shall be limited to 75 dBA as measured at 10 feet in a free field environment. Silencer shall be Maxim, Nelson, or equal. Silencer shall have mounting/seismic restraint lugs, and shall have a one-inch condensate drain connection. A 2-1/2-quart, low pressure, manual drip trap (Varec Figure No. 246, Groth Model 8460, or equal) shall be provided loose for installation by the Contractor. The silencer shall be fabricated of heavy-gauge steel in all-welded construction with inspection ports and drain fittings in each chamber.

H. Flexible couplings for jacket water, lube oil, fuel and exhaust piping shall be provided. Water, oil and fuel connectors shall be single braided, stainless steel, 150 psig working pressure. Fuel connectors shall bear the Underwriters Laboratories label. The exhaust connector shall be unbraided, stainless steel, suitable for temperatures up to 1300 degrees F. All connectors shall be selected for a design of not less than 10,000,000 full displacement cycles. Flexible metal hose shall be by Flexonics, Hyspan, or equal

I. Structural Bracing:
   1. Generator assembly shall be braced by the manufacturer per the seismic requirements of Section 01 73 24 and Drawing S-00-001. Submit bracing information.

2.03 THERMAL INSULATION WRAP

A. General:
   1. Provide thermal insulation wrap or other acceptable method for insulating the hot surfaces on generator engines for personnel and structure safety.

B. Surfaces:
   1. Hot surfaces within the enclosure to protect personnel and structure, as recommended by the manufacturer.

C. Execution:
   1. Provide thermal insulation blanket that is easily removed without damaging the blanket during maintenance or repair of the engine.
   2. Stainless steel removable lacing shall be provided. The use of "hot rings" for binding edges or securing blankets is unacceptable.

2.04 GENERATOR SYSTEM

A. Generator:
   1. The generator shall be synchronous, four pole, revolving field, pre-lubricated bearing, air cooled by a direct drive centrifugal blower fan, and directly coupled to the engine with flexible drive discs.
   2. The armature shall have skewed laminations of insulated electrical grade steel, two-thirds pitch windings. The rotor shall have amortissuer damper windings of layer-wound, mechanically-wedged winding construction. The rotor shall be dynamically balanced.
   3. Insulation system components shall meet NEMA MG1 temperature limits for a Class H insulation system. Actual temperature rise measured by resistance method shall not exceed 125 degrees Celsius to provide additional allowance for internal hot spots.
   4. The generator insulation systems shall be suitably impregnated for operation in severe environments for resistance to sand and other air-born contaminants.

B. Exciter:
   1. A permanent magnet generator (PMG) shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by non-linear loads on the generator.

2. The PMG shall sustain field excitation power for optimum motor starting and shall sustain short circuit current for selective operation and coordination of system overcurrent devices.
3. The PMG exciter insulation systems shall be suitably impregnated for operation in severe environments for resistance to sand and other air-born contaminants.

C. Voltage regulator:
1. The automatic voltage regulator shall be temperature compensated, digitally controlled pulse width modulated solid-state design, and include over-voltage and over-current protection functions.
2. Over-voltage protection shall sense generator output voltage, In the event of regulator failure or loss of reference, the regulator shall shut down its output on a sustained over-voltage of one-second duration.
3. Over-excitation protection shall sense regulator output and shut down its output if overload exceeds ten seconds duration. Both over-voltage and over-excitation protection shall be latched, requiring the generator to be stopped for reset.
4. Generator output voltage shall be maintained within 1% of rated value for any load variation between no load and full load and drift no more than within 0.5% of rated value at constant temperature.

D. Circuit Breaker:
1. The generator mounted circuit breaker shall be mounted and connected in either the control enclosure or an outdoor rated enclosure, and provided with adequate space for customer power cable lug connections.
2. Provide the following:
a. Molded case circuit breaker rated for 100% current, 3-pole, single-throw, stationary-mounted with manual operating handle, overload and short circuit trips, complete with cable lugs.
b. Circuit breaker shall be UL labeled and rated for 600-volt circuits and provided with a solid state over-current trip device.
c. Not used.
d. A circuit breaker with a 24 Vdc shunt-trip unit wired to terminal board.
e. Three current transformers with 5-ampere secondary windings for the ammeter display, as needed.
f. NEC required working access space around the Circuit Breaker enclosure.
g. Cable lugs by supplier, refer to the electrical drawings for circuit conductor sizes and numbers.

2.05 ENGINE-GENERATOR SYSTEMS

A. Engine Starting System:
1. The engine starting system shall include 24 Vdc starting motor(s), starter relay, and automatic reset circuit breaker to protect against butt engagement.
2. Required cables furnished and sized for power feeder circuit requirements and capable of starting the specified engine within 10 seconds at the elevation and ambient environmental conditions specified herein.

B. Water Jacket Heater:

1. Jacket water heater(s) shall be provided to maintain coolant temperature of 32°C (90°F) while the engine not running. Heaters shall accept 240 Vac single phase power and include thermostatic controls.

C. Batteries:

1. Batteries for GenSet starting and control shall be selected and supplied by the GenSet manufacturer. Battery warranty shall be the responsibility of the GenSet manufacturer. Batteries shall be protected from engine fuel leaks.
2. Batteries shall be maintenance free Starting, Lighting, and Ignition (SLI) lead acid type with through-partition connectors and mounted near the starting motor. Batteries shall be mounted on a corrosion resistant or coated steel battery rack close to the starting motor as practical and allow personnel access for inspection and maintenance.
3. Starting batteries shall be rated 24 Vdc with ampere-hour and ampacity sizing to allow for engine oil viscosity, ambient starting temperature, project elevation, and accessories.

D. Alternator:

1. An engine-mounted belt-driven battery charging alternator shall be installed with an automatic voltage regulator. Alternator and regulator suitable for the application with a rating of 24 Vdc.

E. Battery Charger:

1. A dual rate 10-ampere battery charger shall be provided that shall accept 120 Vac single phase input to provide 24 Vdc output.
2. The battery charger shall be fused on the AC input and DC output, and incorporate current limiting circuitry to avoid the need for a crank disconnect relay. The charger shall be rated for operation at plus 50°C ambient. Charger voltage regulator shall be temperature compensated.
3. Not used.
4. A voltage power switch shall be mounted on the face of the charger and shielded from accidental switching. The charger shall include an AC ammeter and voltmeter, a failure malfunction alarm switch, and be housed in an enclosure suitable for mounting inside the outdoor enclosure.
5. Not used.

2.06 FUEL STORAGE SYSTEM

A. Provide 24 hour rated belly fuel tank, fuel level indication, and diesel fuel flowmeter indicating flow rate and flow total.

1. Tank shall be Underwriters Laboratories, Inc. (UL) 2085 ballistic-resistant.
2. Tank shall have UL 142 secondary containment and leak detector.
3. Provide low-fuel alarm to generator controller.

2.07 OUTDOOR ENCLOSURE

A. General:
   1. The acoustical enclosure shall house the engine generator and the auxiliary equipment required for the electric power generating system. The enclosure shall be a weather-protected sound attenuated enclosure complete with AC and DC lighting, field electrical connection provisions and the following modification and features:
      a. Sound Attenuation Enclosure:
         1) The enclosure shall be sound attenuated with composite sandwich construction of perforated metal enclosure either non-flammable mineral fiber or fiberglass.
         2) The acoustical enclosure shall be constructed of 14-gauge minimum galvanized steel modular panel construction with acoustic insulation and perforated liner. Acoustic insulation thickness as well as acoustic inlet/outlet features shall be provided to meet the overall acoustic requirements of paragraph 1.02.
   2. Galvanized perimeter frame structure bracing shall allow the enclosure to be removed as a unit without disassembly. Provide crane lifting eyes where required to move enclosure. Provide peaked roof for rain run-off.
   3. Provide fixed vane weather-proof acoustic intake louvers with hinged access and sized per the engine's cooling and combustion airflow requirements.
   4. Provide interior workspace around both sides, and the rear of the generator.
   5. Provide NEC required 3-foot, 6-inch clear workspace in front of the generator circuit breaker and generator control panel.

B. Doors:
   1. Enclosure shall contain four personnel outside entrance double-gasketed doors for entering the engine/generator compartment. Doors shall be fabricated from 14-gauge galvaneal with heavy duty continuous stainless steel piano hinge with stainless steel fasteners and pins.
   2. Outside door latch mechanism shall be flush mounted and lockable.
   3. No hardware shall protrude beyond the perimeter of the enclosure to facilitate normal handling and shipping aboard container ships or by highway semi-tractor trailer.

C. Surface Preparation and Painting:
   1. Surface preparation and painting for the enclosure by the container manufacture shall be as follows:
      a. Steel sheeting shall be galvanized steel.
      b. Steel components shall be force dried and painted with a two-part epoxy primer and high gloss finish polyurethane topcoat.
      c. Caulk open seams with a sealant to prevent rust seepage after painting.

D. Exterior Color:
   1. The enclosure exterior shall be painted Manufacturer's standard, suitable for field-applied coating.

E. Electrical Connections:
   1. Provide a gasketed terminal box for control and instrumentation wiring, separated from power connections, and show terminal box location in the submittal documentation.

F. Ventilation:
   1. Hinge the fixed vane intake louvers for access and size per the engine's cooling and combustion airflow requirements. Separate the intake louver from the exhaust louver.
   2. Orient each louver to minimize superheating of the intake air. Use air directional acoustic barrier plates to mitigate sound escaping from the enclosure while not impeding airflow necessary for combustion and cooling. Install water separator to catch and drain of standing water on the louvers.
   3. A sound insulated baffle shall be installed six inches below the opening of the fan and shall extend twelve inches beyond the fan opening.

2.08 CONTROLS

A. Engine-Generator Control Panel:
   1. The control panel shall be designed and built by the engine-generator manufacturer and mounted near the generator with vibration dampening mounting devices.
   2. Provide a 100 percent solid state microprocessor based control circuitry, sealed dust tight, watertight modular components, and digital instrumentation. gasketed enclosure ratings. Label the control panel with ISO symbols.
   3. Display critical parameters such as operating hours, engine RPM, battery DC volts, oil pressure, jacket water temperature, including the specified engine and electrical parameters.

B. Engine monitoring Devices:
   1. Engine monitoring signals provided by engine mounted lubricating oil pressure and coolant temperature transducers shall communicated over a serial data link through a Data Sending Unit (DSU) to the control panel receiving module. The safety logic shall shut the engine down if the serial data link is lost.

C. Control Functions:
   1. Provide control panel front mounted devices such as generator voltage control device, ammeter/voltmeter phase selector switch, control selector switches, and pushbuttons. Provide control and monitor devices identified and labeled with ISO symbols.
   2. Provide start-stop logic for cycle cranking and cool down operation and red-mushroom head emergency-stop maintained pushbutton.

D. Control Wiring:
   1. GenSet control wiring:
      a. Number 16 AWG (American Wire Gauge) stranded wire and control panel ground wire
      b. Number 12 AWG with green and yellow striped insulation rated. Conductors shall be rated 90°C 600 Vac insulation with UL or CSA listing.

c. Provide wire identification on the conductor 6-inches from the terminal and protect wire from sharp bends and metal edges.
d. Provide four sets of Form C dry contacts rated at 2 amps for remote customer alarming:
1) Run status.
2) Trouble (pre-alarm) alarm.
3) Shutdown (fail) alarm.
4) Low fuel alarm.

E. Alarm and Shutdown Conditions:
1. Indicate the following alarm and shutdown conditions and provide a RESET device to clear fault:
a. Low oil pressure: pre-alarm
b. High engine temperature: pre-alarm
c. Low engine temperature: pre-alarm
d. Low fuel: pre-alarm
e. Low battery DC voltage: pre-alarm
f. Generator output circuit breaker (trip or off): alarm
g. Generator overload: alarm
h. Low oil pressure: shutdown
i. High engine temperature: shutdown
j. Low coolant level: shutdown
k. Over-crank: shutdown
l. Over-speed: shutdown
m. Over-voltage: shutdown
n. Under-voltage: shutdown
o. Under-frequency: shutdown
p. High battery voltage alarm
q. Low battery voltage alarm
r. Normal battery voltage indication
s. Battery charger malfunction alarm
t. Spare (2): alarm and shutdown

F. Metering:
1. Provide digital metering with 0.5% accuracy. Provide true RMS indication that includes the total harmonic voltage and current content:
a. Voltmeter
b. Ammeter
c. Frequency meter
d. Phase select switch
e. Non-resettable running time

G. Alarm Module:
   1. Provide integral digital alarm annunciator for indication and audible alarm per NFPA Standard 110 on the engine-generator control panel. Provide lamp test switches, alarm horn silence-button, and first-out alarm detection.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. The GenSet shall be installed and connected in accordance with manufacturer's recommendations and the installation shall be certified on Form 43 05 11-A as specified in Section 01 99 90.
   2. Verify the equipment pad is sized for the GenSet size per submittal information, level, with ground pad installed.

B. Signs:
   1. Provide NEMA MG1-22.61 GenSet nameplate. Provide laminated equipment, device, and panel nameplates per specification Section 26 05 00.
   2. Contractor shall provide one sign in accordance with NEC 701.7 for Contractor installation on the Service Entrance Equipment. Sign shall conform to NEC 110.21(B), and shall describe the type and location of the generator: "Standby Generator located West of this Service Entrance.".

C. Conduit Transitions at Slab:
   1. Connection from underground conduits to GenSet equipment shall transition via polyvinyl chlorinated (PVC) coated flexible steel conduits. Loose or open cabling will not be permitted.

D. Protection Post Barriers:
   1. Provide a minimum 4-inch diameter concrete filled 36-inch high posts around the GenSet. Post shall be removable with locking pin device to keep in place. Provide post at each corner within 3-feet from the enclosure and with 3-feet between posts.

E. Intrusion Switches:
   1. Provide intrusion switch for each enclosure doorway. Switches shall be NEMA 4, with Form C contacts.

F. Exterior Color:
   1. Contractor-applied coatings per Section 09 90 00.
   2. Submit exterior paint color chip for approval and provide one gallon of the same paint for touch-up purposes to the Owner.

3.02 FIELD INSPECTION AND TESTING

A. Pre-Delivery Supplier Facility Testing:
   1. Prior to delivery of the GenSet to the project site, test the GenSet to verify it is free of defects, starts automatically, and carry full load. Test shall be performed at the factory.

2. The testing shall be done on dry type, resistive load banks capable of precise incremental loading.
3. Provide separate test grade instrumentation to monitor the GenSet using the load bank. The GenSet monitoring instruments shall be read and compared to the amperage and voltage on each phase. Both readings shall be recorded and compared in the test report.

B. On Site Post-Installation Testing:
1. Following installation, the following tests shall be performed by the system Manufacturer's qualified representative in the presence of the Owner's representative.
2. Pre-start Checks:
   a. Oil level.
   b. Water level.
   c. Fuel level.
   d. Battery connection and charge condition.
   e. Engine to control interconnects.
   f. GenSet intake/exhaust obstructions.
   g. Removal of all packing materials.

C. Field Tests:
1. The GenSet field test shall be performed by factory trained technicians at the project site with test equipment, facilities, and consumables including fuel and lubricants provided by the supplier.
2. The Contractor shall provide a full tank of diesel fuel when the testing is completed and the GenSet is available for operation.
3. Owner’s representatives shall witness the field tests. Contractor shall provide to the Construction Manager written notice of the date field testing will commence a minimum of two weeks prior to that date.
4. The following field tests shall be conducted:
   a. Check electrical exhaust, fuel and water connections for proper size, continuity and tightness of fittings.
   b. Check fluids for appropriate levels and jacket water heater operation.
   c. Start-up engine and make initial start-up check of operational equipment.
   d. Upon completion of initial start-up and system checkout, schedule the witnessed field test to demonstrate load carrying capability, stability, voltage and frequency.
   e. Operate the GenSet for l-hour for proper engine break-in and record water temperature, fuel pressure, oil pressure, ambient air temperature, voltage, amperage, frequency, kilowatts, and power factor.
   f. Operate a minimum of 4-hours under full load with consumables necessary for testing furnished by the bidder.
   g. Return to normal power source and test the ATS transfer from normal power to standby power and the ATS monitoring functions by simulating the loss of normal power source.
   h. Test the ATS initiated "GenSet Start" condition with the load bank.

i. Run the generator for test duration; monitor the oil and water temperatures and record readings every fifteen minutes.
j. Test the GenSet safety devices using methods recommended by the Manufacturer.
k. Setup the unloaded run at the conclusion of the test and the retransfer to normal power to allow engine to cool before engine shutdown.
l. Notify the Owner's representative of problems and the mitigation plan.
m. Submit the formal Test Results Report.

D. Demonstration:
1. Demonstrate proper operation of generator, transfer switch, switchboard, and programmable logic controller (PLC) to the Construction Manager. Demonstration to include simulation of power failure with the most of treatment process pumps and equipment running; generator start and pump and equipment restart; restoration of power failure; pump and equipment transfer to normal power and restart; and generator stop.

3.03 TRAINING

A. The Contractor shall contract with the GenSet manufacturer to provide 4 hours of onsite training for each two shifts for the subjects below. Arrange and schedule the training with the Owner.

B. Training shall include the requirements of Section 01 79 00 and the following:
1. Operations and Maintenance for the Diesel Engine and Fuel System.
2. Operations and Maintenance for the AC Generator.
3. Operations and Maintenance for the Control Panels, Battery System, and Enclosure Systems
4. Operational information for the specific equipment provided.
a. Operation of the equipment in automatic and manual modes.
5. Troubleshooting.
6. Routine maintenance.

C. Training shall be certified on Form 43 05 11-B as specified in Section 01 99 90.

END OF SECTION

SECTION 26 36 23

AUTOMATIC TRANSFER SWITCHES

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies automatic transfer switches (ATS) rated 600 volts and less for lighting, heating, ventilation and air conditioning (HVAC), and motor loads as indicated on the drawings.

B. The ATS shall use electrically-operated, mechanically-held, power rated, electrical contactors to provide double throw switching action with number of poles as shown or specified.

C. Refer to the standby engine-generator interface and interlock requirements in Section 26 32 13.13.

1.02 AUTOMATIC TRANSFER SWITCH SCHEDULE

Tag No.	Location
ATS-001	Intake PS
ATS-91	LeChee WTP

1.03 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid or on the effective date of the Agreement if there were no Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.
3. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEEE Standard 446	Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
NEC Article 701 and 702	National Electrical Code: Legally Required or Optional Standby Systems
NFPA 70 - NEC	National Electric Code

Reference	Title
NEMA ICS 6	Enclosures for Industrial Controls and Systems
NEMA Standard ICS10	AC Automatic Transfer Switches
NFPA 110	Emergency and Standby Power Systems
UL 508	Industrial Control Equipment
UL 1008	Standard for Automatic Transfer Switches

1.04 QUALITY ASSURANCE

A. Listing:
   1. The ATS shall be Underwriters Laboratory listed in accordance with UL 1008.

1.05 SUBMITTALS:

A. The following submittals shall be provided in accordance with Section 01 33 00.

B. Provide separate submittals for each of the Intake PS and LeChee WTP for the following:

C. Action Submittals – Shop Drawings and Product Literature:
   1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. A copy of the Contract Documents' Electrical Drawings, with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "NO CHANGES REQUIRED." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review:
      a. Intake PS: S-001, E-103, E-104, and E-106.
      b. LeChee WTP: S-00-001, E-00-131, E-00-501, and I-00-101.
   3. Arrangement drawings of the transfer switch enclosure indicating the front door and rear panel equipment arrangement and dimensions.
   4. List of materials and components shall accompany the arrangement drawing.
   5. Elementary and internal connection diagrams.
   6. Manufacturers' data marked to indicate momentary, interrupting, and continuous current ratings of all relevant equipment, components, and devices.

7. Structural Bracing and Anchorage:
    a. Manufacturer's written certification confirming that the equipment bracing complies with the specified requirements.
    b. Manufacturer's scaled drawings for the equipment showing internal assembly bracing.
    c. Weight for each complete equipment assembly.
    d. Manufacturer's recommended anchorage requirements in accordance with the specified requirements, if available from the manufacturer.

D. Closeout Submittals – Operation and Maintenance (O&M):
    1. Combined O&M for Intake PS and LeChee WTP is not acceptable.
    2. Applicable O&M information on an item-by-item basis in accordance with Section 01 78 23.
    3. Include the following in each O&M manual:
        a. Final reviewed submittals, including revised as-built drawings.
        b. Manufacturer's O&M instructions, edited for this project.
        c. Written record of menu configuration, jumpers, switch settings, and other configurable parameters per Part 3.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section.

B. Candidate manufacturers include Eaton, GE-Zenith, or Cummins.

2.02 RATING

A. The voltage, current, frequency and number of poles shall be as specified and shown. The ATS shall be rated 480 Vac and rated to close onto and withstand a fault, with the Withstand Closing Rating (WCR) of 65,000 symmetrical amperes.

B. The ATS shall be labeled with ratings. Series rating components are not acceptable.

2.03 FACTORY TEST

A. The ATS shall be factory tested to ensure proper operation.

2.04 CONTROL AND MONITORING

A. The switch shall contain the following devices in the control circuit:
    1. Voltage pickup relay, adjustable 85 to 100 percent.
    2. Frequency pickup relay, adjustable 90 to 100 percent.

3. Time delay relay for open transition from normal to emergency (TDNE): adjustable from 0.2 to 50 seconds, initially set at 0.2 seconds.
4. Time delay relay for open transition from emergency to normal (TDEN): adjustable from 0 to 30 minutes, initially set at 20 minutes.
5. Time delay for open position to allow motor load EMF decay: adjustable from 1 to 10 second, initially set at 7 seconds.
6. Engine cool-down timer: 0-60 minutes, initially set at 30 minutes.
7. ATS transfer test switch mounted on equipment cover or door.
8. Switch position indicating lights:
    a. Green light for normal source and red light for emergency source.
9. Generator Start Command:
    a. Output relay.
10. Engine Generator Exerciser:
    a. Adjustable exerciser with no-load or load transfer, start time, duration, retransfer, and cool-down time.
11. Monitoring:
    a. Event logging with data, time, and reason.
12. Output status and alarm contacts:
    a. Normal Position status (2-sets Form-C)
    b. Standby Position status (2-sets Form-C)
    c. Trouble alarm (2-sets Form-C)

2.05 TERMINATIONS

A. Arrange internal equipment items for power cable bottom entry and bottom exit.

B. Provide oversized termination lugs as required for the size and quantity of conductors shown. Provide copper bus, terminations and connections.

2.06 ENCLOSURE

A. The enclosure shall be floor or supported from the floor mounted and shall be suitable for locations as indicated on the drawings and as described below:
    1. NEMA 12 dust-tight enclosures intended for indoor use primarily to provide protection against circulating dust, falling dirt and dripping non-corrosive liquids.

B. The enclosure painted finish shall be Manufacturers standard.

C. Structural Bracing:
    1. Assembly shall be braced by the manufacturer per the seismic requirements of Structural Drawings and Specifications. Submit bracing information.

2.07 NAMEPLATES

A. The switch shall be identified as indicated on the drawings and nameplates shall be provided in accordance with the requirements of Section 26 05 00.

B. Provide black nameplate with white lettering on front of ATS:
   1. Intake PS Engraving: “AUTOMATIC TRANSFER SWITCH/480 VAC POWER FROM STANDBY GENERATOR LOCATED EAST AND SES LOCATED NORTH OF THIS ATS.”
   2. LeChee WTP Engraving: “AUTOMATIC TRANSFER SWITCH/480 VAC POWER FROM STANDBY GENERATOR LOCATED SOUTH AND SES LOCATED WEST OF THIS ATS.”

PART 3 EXECUTION

3.01 FIELD ADJUSTMENTS

A. The time delay relays shall be adjusted to the following values:
   1. Normal to emergency time delay: 5 minutes
   2. Emergency to normal time delay: 20 minutes
   3. Open Position time delay: 3 seconds
   4. Voltage pickup: 90 percent
   5. Frequency pickup: 95 percent

3.02 FIELD TESTS

A. The following tests shall be performed on the equipment provided under this section. Tests shall be in accordance with the latest version of UL and NEMA standards.
   1. Electrical insulation check to verify the integrity and continuity of the system
   2. Visual inspection to ensure that the switch matches the specification requirements and to verify fit and finish meet quality standards
   3. Mechanical tests to verify that the switch's power sections are free of mechanical hindrances
   4. Test the ATS using engine-generator set per Section 26 32 13.13.

B. The automatic transfer switch shall be acceptance field tested in accordance with Section 26 08 00.

C. Legally Required Standby Systems shall conform to NFPA-70: NEC Article 701 requirements for installation, wiring, grounding, and signage.

D. Configure the ATS for scheduled operation in accordance with Owner test schedule:
   1. Example:
      a. Wednesday at 10 AM, the plant load transfer from the Power Utility to the genset in accordance with the following to verify that the genset and transfer scheme is operational. Provide settings for the automatic test using the ATS transfer timer schedule: Plant load for 2-hours then retransfer to Power Utility.

END OF SECTION

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SECTION 26 41 13

LIGHTNING PROTECTION FOR STRUCTURES

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Provide the lightning protection system design by a qualified Lightning Protection System (LPS) firm registered to design lightning protection systems.
   2. Provide a complete lightning protection system for the following facilities and structures:
      a. LeChee WTP treatment building.
      b. Raw Water Tank.
      c. Finished Water Tank.
   3. Test and certify that the lightning protection system design, installation, and testing comply with the lightning protection industry standards as applied to the project facilities and structures.
   4. Provide the LPS firm with the plant or facilities drawings that indicate the equipment, buildings, structures, and HVAC equipment as the basis for their design work.

B. Coordination:
   1. Lightning Protection Systems design shall be arranged in accordance with the class of structure to be protected.
   2. Coordinate arrangement and connections with roof system proposed for use and roof mounted equipment. Refer to the structural and architectural drawings.

1.02 QUALITY ASSURANCE

A. Quality Control:
   1. Lightning protection system materials shall be the standard product of a manufacturer regularly engaged in the production of lightning protection systems.
   2. Materials shall comply in weight, size, and composition for the class of structure to be protected.
   3. Lightning protection systems shall be installed under the direct supervision of a Lighting Protection System Certified Master Installer.

B. Certification Requirements:
   1. Provide and submit Master Installer Certified forms for the following:
      a. Form LP1-175A - Jobsite Witness of Grounding Connections.
      b. Form LP1-175B - Post-Installation Inspection.
      c. UL Master Label C.

C. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under

this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/IEEE C62.1	Surge Arresters for AC Power Circuits
ANSI/IEEE C62.11	Metal-Oxide Surge Arresters for Alternating Current Power Circuits
LP1-174	Lightning Protection Institute Installation Code
LP1-175	Lightning Protection Institute Standard of Practice
NEC	National Electric Code (NEC)
NFPA-780	Lightning Protection Code
UL Standard No. 96	Lightning Protection Components
UL Standard No. 96A	Master Label Provisions

D. Coordinate with Section 26 42 16.16 for tanks.

1.03 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 00:

B. Action Submittals - Shop Drawings:

1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. A copy of the following Contract Documents' Electrical Drawings A-20-102, E-00-111, E-00-121, and E-00-131, with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "NO

CHANGES REQUIRED." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

3. Manufacturers technical information for materials proposed for use.
4. Complete scaled drawings identifying the system arrangement and equipment connections for each building.
5. Drawings shall include equipment connection details, down-lead details, routing of system conductors, and locations of air terminals. Show interconnection to separate building ground grid.
6. Submit certificates for LP1 Code Compliance together with UL Master Label C certificates.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials:
   1. General:
      a. System materials shall be copper and high copper-content bronze castings.
         1) Fittings, except cable holders, shall be heavy-duty type made from bronze castings.
         2) Terminal rods, bolts, screws, and related type hardware shall be copper clad steel or brass to prevent galvanic corrosion.
   2. Components:
      a. The system shall consist of the necessary equipment as required to provide a complete and coordinated system. Cable and air terminals used shall bear the UL Label. The components shall consist of, but not limited to, the following:
         1) Cables.
         2) Air terminals.
         3) Mounting bases.
         4) Fittings.
         5) Couplings.
         6) Connectors.
         7) Fasteners.
         8) Conduit.
         9) Pitch pads and weatherproof seals.

2.02 MANUFACTURERS

A. The Owner and Construction Manager believe the following candidate firms are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section.

B. The candidate detailed design, product manufacturer, and installation firm shall be one of the following or accepted equal:
   1. Thompson Lightning Protection Inc.

2. AC Lightning Security.

C. Early Streamer Emission (ESE) is prohibited product system.

PART 3 EXECUTION

3.01 INSTALLATION

A. Verify field measurements as indicated on the drawings and as specified elsewhere herein.

B. Conceal system conductors where practical and main down-leads and roof risers shall be concealed within the building walls or columns.

C. Allow six foot minimum clearances as required by the NEC from:
   1. Lightning rod conductors to non-current-carrying metal parts of electrical equipment unless they are bonded to the rods;
   2. Lightning conductors to open conductors of communications systems;
   3. Lightning protection grounding electrodes to electrodes of other grounding systems.

D. Do not use lightning protection rods and electrodes in place of the grounding electrodes for electrical equipment.

E. Run leads in 1-inch Schedule-80 PVC plastic conduit.

F. Terminate upper end above floor ceiling, utilize through-roof connectors for cable roof penetrations. Conduit terminations at lower end to be 6-inch above finished ground level, to pinpoint locations during future inspections.

G. Bond metallic objects and systems at roof level.

H. Primary bonds using appropriate fittings and full-size conductor:
   1. Roof intake and exhaust fans, HVAC units, ductwork, piping, ladders, skylights, stacks, vents, etc.
   2. Down-leads to steel column or major framing member at every down-lead position.

I. Secondary bond using secondary cable and fittings:
   1. Metal bodies of inductance located within six feet of a conductor.
   2. Equipment with primary bond.

J. Connect to structure ground grid system using exothermic welds.

K. Insure installation of air terminals to withstand wind force equivalent to 100 miles per hour with a gust factor of 1.3 without structural damage and without damage to the integrity of the lightning protection system.

L. Interconnect the Lightning Protection System to the building grounding grid at one location.

END OF SECTION

SECTION 26 42 16.16

CATHODIC PROTECTION SYSTEMS FOR STEEL TANKS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section specifies an impressed current cathodic protection system for steel tanks to provide corrosion control. The system shall automatically control the amount of current applied to the raw water and finished water steel tanks specified in Section 33 16 13.13. Both the steel tanks and interior surfaces in contact with the water shall be cathodically protected. The work includes designing, furnishing, installing, testing and commissioning the cathodic protection system to provide the specified corrosion control. The Contractor shall coordinate with the tank manufacturer and provide detailed design services, materials, equipment, labor, and supervision to furnish a system as described in this specification.

B. Type:

1. Each impressed current cathodic protection system shall consist of the following components:
   a. Rectifier with automatic and manual adjustable current output
   b. Anodes and anode suspension system
   c. Reference electrodes
   d. Wiring
   e. Control Panel
   f. Test station
   g. Solid state decoupler for tank grounding.
   h. Access handhole assemblies,

C. Equipment List:

Item	Equipment No.
Interior Cathodic Protection System – Raw Water	CPS-1011
Interior Cathodic Protection System Local Control Panel – Raw Water	LCP-1011
Tank Floor Underside Cathodic Protection System	CPS-002
Tank Floor Underside Cathodic Protection System Local Control Panel	LCP-002
Interior Cathodic Protection System – Finished Water	CPS-3021
Interior Cathodic Protection System Local Control Panel – Finished Water	LCP-3021

D. Operating Conditions:

1. The cathodic protection systems will be installed outdoors in a water treatment plant. Refer below for environmental conditions.

E. Performance Requirements:

1. Each impressed current cathodic protection system shall be designed for continuous duty under the following performance requirements:

Item – Raw Water	CPS-1011	CPS-002
Design current density, mA/ft2	3.0	3.0
Rectifier type	Automatic	Manual
Rectifier turndown capacity	Infinite	Infinite
Setpoint electronegative potential(a)	-850 mV to -1050 mV	-850mV to -1050 mV
Design protected area, ft2	20% (b) (c)	100% (b)
Number of reference electrodes	5	5
Minimum reference electrode life, years	20	20
Minimum anode life, years	20	20
Power requirements, Volts AC	120	120
Water resistivity, ohm-cm	1,083	n/a
Soil resistivity, ohm-cm	n/a	8000 (d)

Item – Finished Water	CPS-3021	CPS-002
Design current density, mA/ft2	3.0	3.0
Rectifier type	Automatic	Manual
Rectifier turndown capacity	Infinite	Infinite
Setpoint electronegative potential(a)	-850 mV to -1050 mV	-850mV to -1050 mV
Design protected area, ft2	20% (b) (c)	100% (b)
Number of reference electrodes	5	5
Minimum reference electrode life, years	20	20
Minimum anode life, years	20	20
Power requirements, Volts AC	120	120
Water resistivity, ohm-cm	2,561.5	n/a
Soil resistivity, ohm-cm	n/a	8000 (d)

(a) Between wall and a saturated copper/copper sulfate reference electrode. Cathodic protection system shall maintain the setpoint potential on all specified protected surfaces.

(b) Refer to tank plans and specifications to calculate the required area to be protected. Specified percentages are bare steel. This should be used with the design current density in designing the CP system.

(c) Use the overflow pipe invert elevation, when shown, to estimate the tank's interior area to be protected. Include all surfaces that come in contact with the water and electrically connected to the tank including pipes, support columns and wet risers, if any.

(d) Represents native soil only. Contractor to include in the design the resistivity of the specified material directly underneath the tank.

F. Environmental Conditions:

1. Ambient conditions are specified in Section 01 11 80.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
API RP 651	Cathodic Protection for Above Ground Petroleum Storage Tanks
AWWA D104	Automatically Controlled Impressed-Current Cathodic Protection for the Interior of Steel Water Tanks
NACE SP0388	Impressed Current Cathodic Protection of Internal Submerged Surfaces of Carbon Steel Water Storage Tanks
NACE SP0193	External Cathodic Protection of On-Grade Carbon Steel Tank Bottoms
NSF 61	Drinking Water System Components – Health Effects

B. Unit Responsibility:

1. The Contractor shall assign unit responsibility, as specified in Section 43 05 11-1.02 Unit Responsibility, to the manufacturer of the cathodic protection system provided under this section. This manufacturer is the unit responsibility manufacturer and has unit responsibility, as specified in Section 43 05 11-1.02 Unit Responsibility, for both the equipment assembly specified in this section and for the Local Control Panel specified in this section. A completed, signed, and notarized Certificate of Unit Responsibility (Section 01 99 90-Form 43 05 11-C) shall be provided.

C. Shipment, Protection, and Storage:

1. Equipment shipment, protection, and storage shall conform to the requirements specified in Section 01 66 00.

D. Manufacturer's Experience:

1. Equipment furnished under this section shall be of a design and manufacture that has been successfully used in similar applications. The manufacturer shall have furnished equipment for a minimum of five similar applications that have been in successful operation for at least five years. A list of these installations complete with installation description, contact names, addresses, and telephone numbers shall be submitted.

E. Warranty and Performance Affidavit:
   1. Cathodic protection system shall be warranted against defects in materials and workmanship of a period of 30 years.

F. Coordinate with Section 26 41 13 for tank lightning protection.

1.03 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 00:

B. Shop Drawings:
   1. A copy of this specification section and the following specification sections, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
      a. Section 33 16 13.13.
   2. A copy of the contract document electrical control single line diagrams E-00-512 and E-00-701, and process and instrumentation diagrams I-10-101 and I-30-101 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   3. Completed Certificate of Unit Responsibility attesting that the Contractor has assigned, and that the manufacturer accepts, unit responsibility in accordance with the requirements of this Section and Section 43 05 11-1.02 Unit Responsibility. *No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.*
   4. Design report that contains all calculations and assumptions including protected surface area, design current density and current distribution.
   5. Manufacturer's specifications verifying the equipment performance. Components and materials in contact with potable water shall meet NSF 61 requirements.
   6. Manufacturer's experience and list of successful installations complete with installation description, contact names, addresses, and telephone numbers.
   7. Control panel layout, dimensions, and connection diagrams.

8. Installation details of all provided components including dimensioned and location information of anodes, reference electrodes, wiring, control panels, and other components. Submittal drawing shall be prepared and sealed by a NACE certificated cathodic protection engineer.
9. Manufacturer's catalog data and shop drawings confirming dimensions, weight, anode composition and configuration, wiring materials, reference electrode composition and configuration and installation details.
10. Descriptive control sequences of the cathodic protection system's manual and automatic operation.
11. Marked product literature and installation instructions marked specific for this project for grounding decoupler.

C. Operation and Maintenance:
   1. Applicable operation and maintenance information as specified in Section 01 78 23, including:
      a. Final reviewed shop drawing submittal.
      b. As-built drawings
      c. Final settings of control panel devices.
      d. Equipment Warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The cathodic protection system shall be designed by a Corrosion Engineer who is an individual accredited by the National Association of Corrosion Engineers (N.A.C.E.) as being a Senior Corrosion Technologist or a Corrosion Specialist with experience in cathodic protection for steel storage tanks.

B. The Corrosion Engineer shall design the system to provide effective corrosion mitigation in accordance with criteria for protection herein. The criteria shall be maintained by an automatically controlled rectifier with an anode and a reference electrode system.

2.02 MATERIALS

A. Materials of components shall be as follows:

Component	Material
Rectifier elements	Silicon
Anodes	Interior CP: Platinum clad niobium wire, minimum 0.062 inch in diameter with minimum 50 micro-inches of platinum Tank floor underside: Mixed metal oxide with titanium substrate
Permanent reference electrode	Copper-copper sulfate per AWWA D104
DC Cable	#10 AWG RHW
Anode cable	#14 AWG HMW/PE
Reference electrode wires	#16 copper with RHW insulation
Anode and reference electrode suspension system, submerged systems	5/16-inch polyester cord

1. Materials specified are considered the minimum acceptable. The Contractor may propose alternative materials. However, alternative materials must provide at least the same qualities as those specified for the purpose. Lesser quality wire insulation such as XHHW or THWN is not acceptable.

2.03 EQUIPMENT

A. Design
   1. Tank floor underside and tank interior surfaces shall have separate cathodic protection systems.

B. Rectifier:
   1. Rectifier shall include the following:
      a. Transformer
      b. Circuit breakers
      c. Lightning, surge and overload protection
      d. Provision for cooling the heat generating components
      e. Volmeter and ammeter
      f. Automatic controller
      g. Mounting system
   2. Enclose the rectifier and associated in the control panel specified in this Section.
   3. Automatic controller shall adjust rectifier's current output to maintain the specified setpoint voltage between the tank and the reference electrode. Automatic controller shall compensate for changes in water level, temperature of water, water chemistry, and cathodic polarization, and shall include the following provisions:
      a. Continuously monitor tank to water potential, free of IR drop
      b. Automatically limit current to a preset value.
      c. Provide potential meter to display tank to water potential
   4. Rectifier mounting system shall either free standing or shall mount directly to the tank exterior.

C. Anode and Reference Electrode Suspension System:
   1. Utilize a Type A anode suspension system in accordance with AWWA D104.
   2. Hang anodes and reference electrodes so that it is in contact with the water throughout the entire range of operating levels. Anodes shall be evenly spaced to assure uniform current density distribution.
   3. Provide means of preventing anodes and reference electrodes from coming in contact with the tank wall during tank filling and draining while preserving the capability for anode inspection and removal through the handholes.

D. Anodes:
   1. Anodes shall be wires or segmented cylindrical strings of the specified material.
   2. Anodes cables shall be continuous without any splices.
   3. Anode cable connection to DC cable shall be made with crimp connectors and shall be made waterproof.][Provide junction box at the DC cable to anode cable connection. Locate the junction box at the tank roof exterior.

E. Reference Electrode:
   1. Reference electrode shall have minimal maintenance and suitable for continuous immersion utilizing 99.9 percent pure copper in a saturated solution of copper sulfate crystals in distilled water. The reference electrodes shall have a potential drift of less than 10 mV.
   2. Reference electrode cables shall be continuous without any splices. Cables shall be of sufficient length so that any cable can be connected to the rectifier controller or terminated to the test station.
   3. For on grade tanks, interior reference electrodes shall be located such that the electronegative potential at the center of the floor and along the walls can be monitored. Tank wall shall be monitored at the low water or at 4-feet above the floor whichever is higher and at 4-feet below the high water level. Low water and high water level wall reference electrodes shall be installed in alternate arrangement and equally spaced.
      a. Floor underside reference electrodes shall be located such that the electronegative potentials at the center and within a foot of the edge of the tank can be monitored. Electrodes located at the edge of the tank shall be equally spaced.
   4. For elevated storage tanks, reference electrodes shall be located such the electronegative potential midway through the wet riser pipe and along the walls can be monitored. Wall reference electrodes shall be located similar to on grade tanks.
   5. Locate reference electrodes between anodes. Minimum number of reference electrodes: five.

F. Test Station:
   1. Test station shall be a NEMA 3R enclosure of sufficient size to house all reference electrode cables. Cables shall be labeled with brass tags identifying the reference electrode location.
   2. Mount test station on the side of the tank wall near the local control panel.
   3. Test station shall allow manual measurement of the potential between the tank and the reference electrode.

4. Test station shall have provision to select the reference electrode to use in as input signal to the rectifier controller. Selection of reference electrode shall be done without the removal of any wires or loosening or tightening of any bolts, screw or nuts.
5. Separate test stations shall be provided for each cathodic protection system.

G. Conduits:
1. House all exposed cables and wires in rigid, PVC coated galvanized steel, thick wall, hot-dipped conduits and fittings. House underground cables and wires in Schedule 80 PVC conduit.

H. DC Cable:
1. DC cables shall be defined as the cables connected to the rectifier's positive and negative terminals. These include the cable that connects to the anode cables and the cable between the rectifier and the tank.
2. A minimum of 1-inch conduit shall be used to house the DC cables.

I. AC Conductors:
1. The conductor on the AC side of the rectifier shall be copper wire with rubber insulation that complies with the requirements of Federal Specification J-C-30.

J. Flange Isolation Kits:
1. Provide flange isolation kits consisting of one full face sealing gasket and one full length insulating sleeve with two steel washers and two insulating washers for each bolt.
2. Insulating gaskets shall be full faced, LineBacker Type "E", 1/8-inch thick, NEMA G-10 retainer containing a precision tapered groove to accommodate the controlled compression of a Teflon or Viton quad-ring sealing element. Sealing element placement shall accommodate either flat, raised face or RTJ flanges. The quad-ring seal shall be pressure energized. The G-10 retainer shall have a 550 volts/mil dielectric strength and a minimum 50,000 psi compressive strength. The full faced flange isolating gasket shall be 1/8" less in I.D. than the I.D. of the flange in which it is installed.
3. Insulating sleeves shall be full length NEMA G-10 sleeve (extending half way into both steel washers) for each flange bolt. Sleeves shall be a 1/32 inch thick tube with a 400 volts/mil dielectric strength and water absorption of 0.10% or less.
4. Isolation washer shall be 1/8 inch thick, NEMA G-10 with compressive strength shall be 50,000 psi, dielectric strength 550 volts/mil and water absorption 0.10% or less. Steel washers shall be 1/8 inch thick. The I.D. of all washers shall fit over the isolating sleeve and the steel and isolating washers shall have the same I.D. and O.D.
5. Flange isolation kits shall be made by Pipeline Seal and Insulator, Inc., or equal.

2.04 CONTROLS

A. Control Description:
   1. Each impressed current cathodic protection system shall have both manual and automatic control. In manual mode, the system shall allow manual adjustment of the rectifier's current output. In automatic mode, the rectifier shall automatically adjust its current output to maintain the specified setpoint cathodic potential between the selected reference electrode and the tank. Failure alarm shall be activated when the cathodic protection system fails to maintain the setpoint voltage within 25mV after an adjustable time delay, 0 – 600 seconds, default 300 seconds.

B. Control Panels:
   1. Provide a NEMA 3R or NEMA 4 weatherproof control panel to house the rectifier and rectifier components specified in this section and all associated controls, switches, relays, indicator lights, and controllers as required herein.
   2. Control panel pilot and displays:
      a. Power ON indicator light.
      b. CP Failure alarm light.
      c. DC voltage output display.
      d. Current output display.
      e. Tank to reference electrode potential display.

C. Control Devices:
   1. Hand-Off-Auto (HOA) selector.
   2. Rectifier current control knob, 0-100 percent capacity.
   3. Required timers, contacts, relays, switches and other accessories necessary for the cathodic protection system to operate as described in this Section.

D. Remote Outputs:
   1. Power ON status.
   2. Failed alarm.

2.05 GROUNDING SOLID-STATE DECOUPLER

1. Provide decoupler for connection of the tank to ground while maintaining cathodic protection. Decoupler shall be rated for absolute threshold voltages of +/- 2 Volts DC, lightning surge current of 100kA crest, AC steady-state current of 45 Amps AC RMS, and AC Fault Current of 5.0 kAmps for 30 cycles AC. Enclosure shall be rated IP68 submersible. Provide Dairyland Electrical Industries model SSD, or approved equal.

2.06 PRODUCT DATA

A. The following product data shall be provided in accordance with Section 01 33 00:
   1. Manufacturer's Installation Certification Section 43 05 11-Form A
   2. Manufacturer's Instruction Certification Section 43 05 11-Form B.

PART 3 EXECUTION

3.01 INSTALLATION

A. The cathodic protection system shall be installed by NACE certificated personnel trained and qualified in the installation of such systems in accordance with the following requirements:
   1. Fittings on the water tank shall be installed by the tank manufacturer.
   2. Materials and equipment shall be inspected prior to installation and defective component shall be replaced. Replace any damaged cables and wiring. Cable and wire field splicing shall not be permitted.
   3. Electrical work shall be in accordance with the National Electric Code and applicable local code requirements.
   4. All electrical connections within the tank shall be sealed to prevent water migration.
   5. Installation shall be certified by the Installer on Form 43 05 11-A specified in Section 01 99 90

B. General:
   1. Grounding for the tank and all electrical equipment and conduits shall be via the solid-state decoupler, and not directly to earth ground system.
   2. Cables and wires shall be installed to prevent damage from abrasion.
   3. The rectifier control panel shall be mounted in a cabinet with the top of cabinet at six feet above grade for monitoring and service purposes.
   4. Locate rectifier control panel at the northeast tank quadrant (45 degree with the North-South line).
   5. Provide nameplate for each Local Control Panel: "(LCP number) / (Tank or Reservoir Name) CATHODIC PROTECTION / 120VAC POWER FROM LC-002"

3.02 FIELD TESTING

A. Provide cathodic protection system Manufacturer authorized Supplier start-up services which includes energizing, testing, and adjusting the system for optimum performance of the cathodic protection system. Coordinate field testing with the Construction Manager.

B. Include the start-up measurements in the Operations and Maintenance Manual. The following shall be measured and documented:
   1. Anode weight and/or length
   2. Rectifier setpoint electromotive force
   3. Rectifier current output
   4. Tank water level
   5. Tank to water potential, IR drop free for all anodes
   6. Tank to soil potential, IR drop free for all anodes
   7. Date of measurements
   8. Cathodic protection firm contact information

C. The final test and adjustment of the systems shall be conducted approximately twelve months after the start-up service has been performed. Repairs needed during the final test and adjustment to the system shall be included at no additional cost. The final tests and adjustments shall be documented similar to the documentation done during start-up testing. Final test and adjustment documentation shall be provided to the Construction Manager.

3.03 TRAINING

A. A minimum of two sets of 3 hours of training conforming to the requirements of Section 01 45 20[shall be provided by the cathodic protection system Supplier. Training shall be certified by the Manufacturer on Form 43 05 11-B specified in Section 01 99 90.

3.04 SERVICE AGREEMENT

A. Include a service agreement from the protection system Supplier in the Operations and Maintenance Manual for the cathodic protection system that includes the annual service rate and a description at the scope of work proposed. The agreement for annual inspection and potential testing shall include as a minimum:
   1. Annual inspection visit. Inspect exposed (not in a conduit) anode and reference electrode cables and wires for wear, fraying and insulation damage. Inspect all cable connections for arcing, corrosion and wear. Inspect anode suspension system for integrity.
   2. Document individual anode material consumption by taking weight and/or length measurements. Estimate remaining anode life based on material consumption rate.
   3. Verify individual reference electrode's electromotive force is within industry standards using a portable calibrated copper-copper sulfate reference electrode.
   4. Document tank-to-water potential and tank-to-soil potential measurements and locations after verifying reference electrode as stated in the preceeding paragraph . For any reference electrode that is not to standard, measurements shall be conducted with a portable high impedance voltmeter and a portable calibrated copper-copper sulfate electrode. Measurements shall be performed at the same locations during each site visits. All instruments and materials for the Finished Water Reservoir in contact with potable water shall meet NSF 61 requirements.
   5. Adjust system for optimum corrosion in accordance with criteria specified in this.
   6. Data recorded shall provide sufficient information to evaluate the performance of the system relating to criteria for protection. Data documentation shall follow the same format used during start-up testing.
   7. In the event additional work is required, submit a report with recommendations for optimizing corrosion mitigation control.

END OF SECTION

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SECTION 26 43 13

SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. Provide SPD with electrical characteristics and ratings for service entrance equipment, switchboards, and panelboards specified in the Division 26 electrical distribution equipment specification sections or indicated on the Drawings. Provide SPD with the same voltage, phase, 3 or 4 wire system as the host electrical equipment.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids).
3. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.
4. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI / Underwriters Laboratories 1449 Latest Edition	Surge Protective Devices
Underwriters Laboratories 1283 3rd Edition	Electromagnetic interference filter for noise attenuation
MIL STD 220A, Rev A, Change Notice #2	Method of Insertion Loss Measurement
ANSI / IEEE C62.41	IEEE Recommended Pratice for Surge Voltages in Low-Voltage AC Power Circuits

1.03 SUBMITTALS

A. The following information shall be submitted under Section 26 21 16, 26 24 13, and 26 24 16 as applicable.

B. Provide separate submittals for each of the Intake PS, LeChee WTP, and the LeChee PS No. 3 for the following:

C. Action Submittals –Shop Drawings and Product Literature:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. Provide verification that the SPD complies with the required American National Standards Institute/Underwriters Laboratories (ANSI/UL) 1449 listing by UL or other Nationally Recognized Testing Laboratory (NRTL).
3. Compliance: File number verified on UL's website or other NRTL's website, with the following information:
    a. Model number.
    b. SPD Type.
    c. System voltage, phases.
    d. Protection modes.
    e. Voltage Protection Rating (VPR).
    f. Nominal Discharge Current (In).
4. Drawings showing unit dimensions, weights, installation instruction details, and wiring configuration for sidemount SPD mounted external to electrical assembly.

D. Closeout Submittals – Operation and Maintenance (O&M).

1. Applicable O&M information on an item-by-item basis in accordance with Section 01 78 23.
    a. Final reviewed submittals, including revised As-Built Record Drawings.
    b. Manufacturer's O&M instructions, edited for this project.

1.04 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. The manufacturer shall be ISO 9001 or ISO 9002 certified for the equipment specified herein.

C. The manufacturer shall have produced similar electrical equipment for a minimum period of five years.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The listing of manufacturers does not imply acceptance of products that do not meet the specified ratings, features, and functions. Manufacturers listed shall meet the specifications in their entirety.

B. Products in compliance with the specification and manufactured by others not named will be considered if pre-approved by the Engineer ten days prior to bid date.
   1. Eaton.
   2. Schneider – Square D.

2.02 SURGE PROTECTIVE DEVICES

A. Electrical Requirements:
   1. Refer to drawings for operating voltage and unit configuration.
   2. Maximum Continuous Operating Voltage (MCOV):
      a. Not be less than 125% of the nominal system operating voltage.
   3. SPD suppression system include thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and other distribution levels.
   4. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may lead to system upset or create environmental hazards.
   5. SPD shall protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

	Protection modes			
Configuration	L-N	L-G	L-L	N-G
Wye	●	●	●	●
Single Split Phase	●	●	●	●

   6. Nominal Discharge Current (In):
      a. SPDs applied to the distribution system shall have a 20kA In rating that include Types 1 and 2 or operating voltage. SPD's with "In" that is less than 20kA, shall be rejected.
   7. Voltage Protection Rating (VPR): The maximum VPR for the device shall not exceed the following:

Modes	**208Y/120**	**480Y/277**
L-N; L-G; N-G	700	1200
L-L	1200	2000

B. Surge Protective Device Design:
   1. SPD's containing replaceable modules, replaceable fuses, replaceable batteries, requiring maintenance, or requiring diagnostic test kit shall not be accepted.
   2. Balanced Suppression Platform:
      a. The surge current shall be equally distributed to MOV components for equal stressing with equal impedance paths to each matched MOV.
   3. Electrical Noise Filter:
      a. EMI/RFI noise rejection filter for noise attenuation of line noise of 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method.
   4. Internal Connections:
      a. Plug-in component modules or printed circuit boards shall not be used as surge current conductors. Components shall be soldered, hardwired with connections utilizing low impedance conductors.
   5. Monitoring Diagnostics:
      a. SPD monitoring:
         1) Status:
            a) Green/red solid-state indicator light for status of the protection on each phase.
               (1) For wye configured units, provide indicator lights for status of protection elements and circuitry in the L-N and L-G modes and in the N-G mode.
               (2) For delta configured units, provide indicator lights status of protection elements and circuitry in the L-G and L-L modes.
               (3) The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode.
               (4) Status indicators indicate the protection on each phase or mode. If power is removed from any one phase, the indicator lights shall indicate the status of the protection on other phases and protection modes.
            b) Remote Alarm:
               (1) Provide Form C dry contacts (one NO and one NC) for remote annunciation. Both contacts change state under fault condition.
            c) Audible Alarm and Silence Button:
               (1) Audible alarm activates upon fault conditions. Alarm silence button silences the audible alarm.
            d) Surge Counter:
               (1) LCD display indicates number of surges and trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton allows the surge counter to be zeroed and contains a mechanism to prevent accidental resetting of the counter.
         2) Overcurrent Protection:
            a) The unit shall contain thermally protected MOVs shall disconnect the MOV(s) from the system during a thermal runaway condition.
         3) Design:

a) SPD's components and diagnostics shall be contained within one discrete assembly.

4) Safety Requirements:
   a) SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts.
   b) SPD's designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit and required conductors be factory installed.
   c) Sidemount SPD's shall be factory sealed in order to prevent access to the inside of the unit with factory installed phase, neutral, ground and remote alarm contacts shall have conductors protruding outside of the enclosure for field wiring.

2.03 SYSTEM APPLICATION

A. Minimum surge current capacity:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category

Category	Application	Per Phase	Per Mode
C	Service Entrance Locations, Switchboards	240kA	120kA
A	Branch Locations: Panelboards	120 kA	60 kA

B. SPD's installed on the line side of the service entrance disconnect:
   1. Type 1.

C. SPD's installed on the load side of the service entrance disconnect:
   1. Type 1 or 2.

D. Panelboard Requirements:
   1. Where SPDs areq required for panelboards, provide SPDs tested for application within ANSI/IEEE C62.41 Category B environments.
   2. SPD's installed following the load side of the main breaker and in main lug only panelboards installed following the incoming main lugs.
   3. SPD connected to a circuit breaker for disconnecting purposes may be installed using short lengths of conductors integrally to the SPD and located directly adjacent to the 30A circuit breaker.
   4. SPD shall be mounted within the panelboard by the manufacturer.
   5. SPD shall be of the same manufacturer as the panelboard.
   6. Panelboard including the SPD shall be UL67 listed.

E. Service Entrance and Switchboard Requirements:
   1. Where SPDs are required for switchboards, provide SPDs tested within ANSI/IEEE C62.41 Category C environments for service entrance locations
   2. SPD shall be of the same manufacturer as the switchboard.
   3. SPD shall be factory installed inside the switchboard at the assembly point by the original equipment manufacturer.

4. Locate SPD on the load side of the main disconnect device, close to the phase conductors and the ground/neutral bar.
5. SPD connected through a disconnect (circuit breaker) located in immediate proximity to SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD shall be as short as possible per the factory specifications.
6. Monitoring and diagnostic features shall be visible on the front of equipment.

PART 3 EXECUTION

3.01 GENERAL

A. Host equipment Manufacturer's representative shall visit the site, verify installation and testing, and verify that the SPD equipment and SPD installation meets intent of the Contract Documents and manufacturer's warranties and that the guarantees are in effect.

3.02 INSTALLATION

A. Install according to manufacturers recommendations.

B. Lead lengths shall not exceed manufactures recommendation.

C. Electrical equipment manufacturer shall authorize and perform bus taps connections, as necessary.

3.03 TRAINING

A. Provide a minimum of 1 hour of training for SPD systems and conforming to the requirements of Section 01 79 00. Training shall be certified on Form 43 05 11-B specified in Section 01 99 90.

END OF SECTION

SECTION 26 51 19

LED INTERIOR LIGHTING

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies light emitting diode (LED) indoor lighting fixtures, features and installation.

B. Terminology used in this Section conforms to the following definitions: Nomenclature and Definitions for Illuminating Engineering Lighting terminology as defined in Illuminating Engineering Society IES RP-16-17.

1.02 QUALITY ASSURANCE

A. REFERENCE STANDARDS:

1. This Section incorporates by reference the latest revisions of the following documents as part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
2. References to documents shall are in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall be the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document, before it was discontinued.

Reference	Title
NFPA 70	National Electrical Code (NEC)

B. SPECIAL WARRANTY: Provide a Special Warranty for LED lightings that shall include the following:

1. The written 5-year on-site replacement includes parts, material, fixture finish and workmanship. Provide on-site fixture replacement includes transportation, removal, and installation of new products.
2. The fixture finish shall include failure or substantial deterioration such as blistering, cracking, peeling, chalking or fading.
3. The replacement material warranty shall include defective or non-starting LED source assemblies and on power supply units.
4. The replacement warranty shall include lighting fixtures producing inadequately maintained illuminance levels at the end of the warranty period, as prorated from levels expected at end of useful life.
5. The warranty period shall begin on the date of Substantial Completion.
6. The Contractor shall provide the Owner with appropriate signed 5-year warranty certificates.
7. The Owner shall receive these certificates prior to final payment.

1.03 SUBMITTALS

A. PROCEDURES: Section 01 33 00 – Submittal Procedures.

B. Provide separate submittals for each of the Intake PS, LeChee WTP, and the LeChee PS No. 3 for the following:

C. Action Submittals –Shop Drawings and Product Literature:

1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. A copy of the following Contract Documents' Electrical Drawings, with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "NO CHANGES REQUIRED." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
    a. Intake PS: E-101 through E-103, and E-105.
    b. LeChee WTP: E-00-311, E-00-321, and E-00-711.
    c. LeChee PS No. 3: E-101, and E-102.
3. Manufacturer's descriptive catalog literature for all lighting fixtures and accessories being installed under this section. Catalog information describing fixture make, materials, and dimensions.
4. Information shall include manufacturer, wattage, voltage, mounting configuration, and lamp type. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.
5. The Contractor may propose an alternate luminaire for approval; however, sufficient information shall be provided as a part of the submittal for the Engineer and the Owner to review and compare the listed luminaire and the proposed alternate.
    a. The Contractor and lighting supplier shall provide a photometric, energy usage (efficiency), approvals/listings and materials comparison between the two fixtures.
    b. If an alternate lighting fixture layout is required, the Contractor and lighting fixture supplier shall provide all illuminance calculations as part of the submittal to verify minimum illuminance levels are met by the proposed revisions.
    c. Proposed alternates shall be shown to be equivalent or superior to the fixture listed. It shall be the Contractor's responsibility to provide sufficient information to the Engineer and the Owner to verify and approve alternates.

PART 2 PRODUCTS

2.01 GENERAL

A. Lighting materials, including fixtures, accessories, and hardware, shall conform to the requirements specified on the Lighting Fixture Schedule on the project drawings.

B. Lighting fixtures shall be provided where shown on the drawings. The drawing's light fixture placement is diagrammatical. The fixture layout shall be coordinated with the various trades to provide access to the fixture and to avoid installed equipment interference.

2.02 LED LIGHTING

A. Lighting fixture model numbers are provided on the drawings in the lighting fixture schedule. The manufacturer's catalog numbers listed are examples of the basic model or series.

PART 3 EXECUTION

3.01 GENERAL

A. The location and type of light fixtures and control are shown on the drawings.

B. Lighting circuit raceways and conductors shall be sized by the contractor, where the circuits are not shown on the drawings.

C. Raceways and wire shall be provided from the fixtures and switches to the lighting panel in accordance with the NEC.

D. Raceways shall be provided in accordance with Section 26 05 33 – Raceways and Boxes for Electrical Systems.

E. Circuit wire shall be provided in accordance with Section 26 05 19 – Low Voltage Power Conductors.

F. Fixtures labeled to require conductors with a temperature rating exceeding 75 degrees C shall be spliced to circuit conductors in a separately mounted junction box. Fixture shall be connected to junction box using flexible conduit with a temperature rating equal to that of the fixture.

G. Labels and marks, except the UL label, shall be removed from exposed parts of the fixtures. Fixtures shall be cleaned when the project is ready for acceptance.

H. Where recessed fixtures are required, the fixture shall be provided with mounting hardware for the ceiling system specified.

I. A concealed latch and hinge mechanism shall be provided for access to the lamps and ballasts and for removal and replacement of the diffuser without removing the fixture from ceiling panels.

J. Fixtures recessed in concrete shall have protective coating of bituminous paint.
   1. Fixtures shall be aligned and directed to illuminate an area as specified.
   2. Fixtures shall be directly and rigidly mounted on their supporting structures.
   3. Conduit system shall not be used to support fixtures.
   4. Where brackets or supports for lighting fixtures are welded to steel members, the welded area shall be treated with rust-resistant primer and finish paint.

K. Tighten electrical connectors and terminals according to manufacture's published torque-tightening values or use torque values specified in UL 486A and UL 486B.

L. Verify normal operation of each fixture.

M. Interrupt the power supply to demonstrate emergency lighting operation to battery power source or alternate power source. Retransfer to normal power supply.

N. Replace damaged fixtures.

END OF SECTION

SECTION 26 56 19

LED EXTERIOR LIGHTING

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies light emitting diode (LED) exterior lighting fixtures features and installation.

B. Terminology used in this Section conforms to the following definitions: Nomenclature and Definitions for Illuminating Engineering Lighting terminology as defined in Illuminating Engineering Society IES RP-16-17.

1.02 QUALITY ASSURANCE

A. REFERENCE STANDARDS:

1. This Section incorporates by reference the latest revisions of the following documents as part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
2. References to documents shall are in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall be the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document, before it was discontinued.

Reference	Title
NFPA 70	National Electrical Code (NEC)

B. SPECIAL WARRANTY: Provide a Special Warranty for LED lighting that shall include the following:

1. The written 5-year on-site replacement includes parts, material, fixture finish and workmanship. Provide on-site fixture replacement includes transportation, removal, and installation of new products.
2. The fixture finish shall include failure or substantial deterioration such as blistering, cracking, peeling, chalking or fading.
3. The replacement material warranty shall include defective or non-starting LED source assemblies and on power supply units.
4. The replacement warranty shall include lighting fixtures producing inadequately maintained illuminance levels at the end of the warranty period, as prorated from levels expected at end of useful life.
5. The warranty period shall begin on the date of Substantial Completion.
6. The Contractor shall provide the Owner with appropriate signed 5-year warranty certificates.
7. The Owner shall receive these certificates prior to final payment.

1.03 SUBMITTALS

A. PROCEDURES: Section 01 33 00 – Submittal Procedures.

B. Provide separate submittals for each of the Intake PS, LeChee WTP, and the LeChee PS No. 3 for the following:

C. Action Submittals –Shop Drawings and Product Literature:

1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. A copy of the following Contract Documents' Electrical Drawings, with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "NO CHANGES REQUIRED." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
    a. Intake PS: E-100 through E-103, and E-105.
    b. LeChee WTP: E-00-101, E-00-102, E-00-311, E-00-321, and E-00-711.
    c. LeChee PS No. 3: E-101 and E-102.
3. Manufacturer's descriptive catalog literature for all lighting fixtures and accessories being installed under this section. Catalog information describing fixture make, materials, and dimensions.
4. Information shall include manufacturer, wattage, voltage, mounting configuration, and lamp type. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.
5. Referenced catalog numbers may not include voltage, mounting style, modifications, and other special features that are specified. The Contractor, supplier, and manufacturer shall provide the specified requirements.
6. The Contractor may propose an alternate fixture for approval; however, sufficient information shall be provided as a part of the submittal for the Engineer and the Owner to review and compare the listed luminaire and the proposed alternate.
    a. The Contractor and lighting supplier shall provide a photometric, energy usage (efficiency), approvals/listings and materials comparison between the two fixtures.
    b. If an alternate lighting fixture layout is required, the Contractor and lighting fixture supplier shall provide all illuminance calculations as part of the submittal to verify minimum illuminance levels are met by the proposed revisions.

c. Proposed alternates shall be shown to be equivalent or superior to the fixture listed. It shall be the Contractor's responsibility to provide sufficient information to the Engineer and the Owner to verify and approve alternates.

PART 2 PRODUCTS

2.01 GENERAL

A. Lighting materials, including fixtures, accessories, and hardware, shall conform to the requirements specified on the Lighting Fixture Schedule on the project drawings.

B. Lighting fixtures shall be provided where shown on the drawings. The drawing's light fixture placement is diagrammatical. The fixture layout shall be coordinated with the various trades to provide access to the fixture and to avoid installed equipment interference.

2.02 EXTERIOR LIGHTING POLES

A. Provide lighting poles with pole cap, hand holes, ground lug, and the necessary fixture mounting hardware.

2.03 SITE JUNCTION BOXES

A. Boxes shall be precast concrete, set flush with the ground. Size shall be approximately 10 x 16 x 12 inches deep.

B. Lid shall be cast iron with permanent inscription: "LIGHTING". Boxes shall be Brooks Products, Oldcastle Precast, Forni Corporation, Utility Vault Company, Christy Concrete Products, or equal.

C. Examples: Jensen Precast Pull Boxes 10" x 17", Oldcastle, Brooks Products, Christy, J&R, Caltrans. HT = High Traffic Pull Box.

2.04 PHOTOELECTRIC CELL UNITS

A. Photoelectric cell units shall in a plug receptacle assembly.

B. The plug receptacle assembly shall be three-prong polarized locking type.

C. Assembly shall be suitable for outdoor mounting.

2.05 LED LIGHTING

A. Lighting fixture model numbers are provided on the drawings in the lighting fixture schedule. The manufacturer's catalog numbers listed are examples of the basic model or series..

PART 3 EXECUTION

3.01 GENERAL

A. The location and type of light fixtures and control are shown on the drawings.

B. Lighting circuit raceways and conductors shall be sized by the contractor, where the circuits are not shown on the drawings.

C. Raceways and wire shall be provided from the fixtures and switches to the lighting panel in accordance with the NEC.

D. Raceways shall be provided in accordance with Section 26 05 33 – Raceways and Boxes for Electrical Systems.

E. Circuit wire shall be provided in accordance with Section 26 05 19 – Low Voltage Power Conductors.

F. Fixtures labeled to require conductors with a temperature rating exceeding 75 degrees C shall be spliced to circuit conductors in a separately mounted junction box. Fixture shall be connected to junction box using flexible conduit with a temperature rating equal to that of the fixture.

G. Photoelectric cells, where specified, shall be oriented toward the north.

H. Labels and marks, except the UL label, shall be removed from exposed parts of the fixtures. Fixtures shall be cleaned when the project is ready for acceptance.

I. A concealed latch and hinge mechanism shall be provided for access to the lamps and ballasts and for removal and replacement of the diffuser without removing the fixture.

J. Fixtures recessed in concrete shall have protective coating of bituminous paint.
   1. Fixtures shall be aligned and directed to illuminate an area as specified.
   2. Fixtures shall be directly and rigidly mounted on their supporting structures.
   3. Conduit system shall not be used to support fixtures.
   4. Where brackets or supports for lighting fixtures are welded to steel members, the welded area shall be treated with rust-resistant primer and finish paint.

K. Underground and outdoor wire splices shall be in accordance with Section 26 05 19.

L. Tighten electrical connectors and terminals according to manufacture's published torque-tightening values or use torque values specified in UL 486A and UL 486B.

M. Provide a minimum of one junction box for the distribution of outdoor lighting circuits within ten feet of building and as required. Circuit's raceways and conductors shall be terminated and spliced, respectively at new junction box. Provide watertight U.L. Listed splices for the circuits.

N. Verify normal operation of each fixture.

O. Replace damaged fixtures.

END OF SECTION

SECTION 27 13 23.23

SINGLE-MODE FIBER OPTIC PROCESS CONTROL NETWORKS

PART 1 GENERAL

1.01 SCOPE

A. This section specifies requirements for indoor/outdoor rated single-mode fiber optic data communication cables including installation, terminations, termination cabinets, testing, and accessories for the LeChee PS No. 3.

B. Provide tools, supplies, materials, equipment, test equipment and the labor for the raceways system, cable installation, and testing of a complete and operable fiber optic cabling system as specified herein on the Cable Specification Sheets.

C. Provide fiber optic cable with each fiber usable and tested as specified herein.

D. Provide the fiber optic cable splices and appurtenances required to complete the fiber optic cabling system. Appurtenances are specified herein.

E. Refer to the drawings and drawing notes for specific requirement for the project, since not all specified products, methods, and procedures are applicable to the project.

1.02 QUALITY ASSURANCE

A. Manufacturer:

1. Equipment and cabling shall be the product of firms regularly engaged in the design and manufacturer of equipment and cables for a minimum of five years. Manufacturer shall have minimum of seven years experience and shall be ISO 9001 certified.

B. Installer:

1. Installation, termination, and testing of equipment and cabling provided under this section shall be performed by qualified, skilled technicians regularly engaged in fiber optic cabling system work of similar complexity and who possess the licenses or certificates required to perform such work.

C. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AASHTO	HS-20 Truck Loading
ASTM F 512	Smooth-Wall Poly (Vinyl Chloride)(PVC) Conduit and Fittings for Underground Installation
ANSI/ICEA S-87-640	Standard for Optic Fiber Outside Plant Communications Cable.
ANSI/TIE/EIA 568-B.3	Commercial Building Telecommunications Cabling Standard part 3
BELLCORE GR-20-CORE	Generic Requirements for Optical Fiber and Optical Fiber Cables
BELLCORE GR-409-CORE	Generic Requirements for Intrabuilding Fiber Cable
BELLCORE GR-487-CORE	Generic Requirements for Electronic Equipment Cabinets
BELLCORE GR-771-CORE	Generic Requirements for Fiber Optic Splice Closures
ISO 9001	Quality Management Systems
ITU G.652	Recommendation - Characteristics of a single-mode optical fiber cable.
ANSI/NECA 301	National Electrical Contractors Association – Standard for Installing and Testing Fiber Optic Cables
TIA/EIA-455-86	FOTP-86 Fiber Optic Cable Jacket Shrinkage
TIA/EIA-455-107A	FOTP-107 Determination of Component Reflectance or Link/System Return Loss Using a Loss Test Set
TIA/EIA-526-7	Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
TIA/EIA-598-B	Standard for Optical Fiber Cable Color Coding
NFPA 70	National Electric Code (NEC)

D. Factory Test:
   1. Manufacturer's factory testing shall be conducted for all fiber optic cable reels provided for this Contract. Test documentation shall include the following:
      a. Measurement of fiber length using Optical Time Domain Reflectometer (OTDR).
      b. Measurement of average attenuation using OTDR.
      c. Traces of OTDR measurements taken.
      d. Test for short distance cable fault detection using Visual Tracer.

E. Certification:
   1. Splicing, terminating, and testing shall be conducted by Fiber Optics Association Certified Fiber Optic Technicians (CFOT).

1.03 SUBMITTALS

A. The following information shall be submitted for review in accordance with Section 01 33 00.

B. Provide submittals for the LeChee PS No. 3.

C. Action Submittals – Shop Drawings and Product Literature:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. *Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.*
2. A copy of the following Contract Document fiber-optic plan drawings, with addendum updates included, marked to show deviations. If no changes are required, the drawings shall be marked "No Changes Required." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review:
    a. LeChee PS No. 3: E-100, E-102, and I-001.
3. Manufacturer's specifications, data sheets, and catalog literature for the indoor/outdoor rated fiber optic cable that clearly and unambiguously shows that the cable meets all the requirements specified herein:
4. Manufacturer's catalog literature and catalog data sheets for the following items, marked to indicate products proposed, as applicable to the project:
    a. Fiber optic cables including manufacturers' maximum recommended pulling tension.
    b. Fiber optic cable termination connectors.
    c. Fiber optic adapter plug-in.
    d. Fiber optic patch cord storage.
    e. Fiber optic cable clamp kit.
    f. Connector/Adapter cleaning kit.
    g. Cable pulling grips, swivel, and lubricant.
5. Interconnection cable diagrams for the complete system, showing each fiber in each cable with each splice and termination point.

D. Qualifications, may be included with Product Literature submittal:

1. Contractor's experience and resumes for the personnel installing and testing the fiber optic system including factory training certifications.

2. Information on five successfully performed cable installations of comparable size and complexity with name, address, and telephone number of facility owner, name of project and completion date, and type of conduit system and length of cable pulled.
3. Proof of certification for splicing, terminating, and testing personnel per paragraph 1.02E Certification.

E. Not used.

F. Action Submittals - Fiber cable pulling and splicing plan as specified in paragraph 3.02.

G. Informational Submittals – Cable pull records as specified in Part 3.

H. Informational Submittals – Results of all tests specified in Part 3.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide fiber optic cable jacket: free of holes, splits, and blisters with no metal elements and of a consistent thickness.

2.02 PULL BOXES

A. Unless otherwise shown, provide pull boxes with the approximately dimensions of 30 inches wide by 48 inches long, by 18” deep with hollow bottoms, designed for H-20 traffic loading.

B. Pull box covers shall be galvanized steel with the words "FIBER OPTICS" in raised letters on the upper surface. Covers shall have locking devices and form a watertight seal to prevent surface water from entering. Knockouts in the sidewalls shall permit underground conduit side entry and exit.

C. Pull boxes shall by George Ingraham, Vikamatic or equal.

2.03 CONDUIT SEALANT

A. Conduit sealant shall be Semco duct sealing compound or equal.

2.04 IDENTIFICATION TAPE

A. Provide a 6-inch wide magnetically detectable warning tape with orange protective polyethylene jacket. Provide polyethylene tape continuously imprinted "CAUTION-FIBER OPTIC CABLE".

B. Identification warning tape shall be Teletrace by George Ingraham, Vikamatic, or equal.

2.05 TRACER WIRE

A. Provide a #12 AWG XHHW insulated green stranded copper wire with a multi-pin terminal block for termination of the tracer wire in pullbox for tracer wire access.

2.06 PULL ROPE

A. Provide a low friction, polyethylene jacketed, polypropylene rope with 1,800 psi of tensile strength.

B. Pull rope shall be Vikamatic "Fiber Glide" or equal.

2.07 NOT USED

2.08 SLACK ENCLOSURES

A. Provide slack enclosure with minimum inside dimensions of 30 inches x 24 inches x 9-1/2 inches.

B. Slack enclosure shall be Carlon SLK 12 or approved equivalent.

2.09 NOT USED

2.10 CABLE IDENTIFICATION TAGS

A. Provide identification tags:
"From: _____ To:_____Circuit:_____Purpose:_____".

B. Cable identification tags shall be Brady or Thomas & Betts or equal.

2.11 FIBER OPTIC BUFFERED CABLE CONNECTORS AND PATCH CORDS

A. General:
   1. Provide preparation for the connections including polishing, connectors, hardware, cleaving tool, continuity tester, visual fault locator, and supplies for installation of connectors. Terminations shall be type as required by the Switch specified in Section 40 67 00. Fusion-spliced pigtails are not acceptable.
   2. Fiber optic cable connections shall be provided with ceramic ferrules, polycarbonate not acceptable.

B. Connector Characteristics:
   1. Connectors shall be specifically designed for fiber optic buffered cables specified herein.

C. Patch Cord Characteristics:
   1. Patch cords shall be 8.3 µm single 125 µm coated duplex fiber with jacket and connectors on both ends. Attenuation shall be a maximum of 0.2 dB. Provide length required for connection from patch panel to equipment. Color: Yellow.

2.12 NOT USED

PART 3 EXECUTION

3.01 RACEWAY SYSTEM

A. Conduit Installation:

1. Conduit bends shall have a radius of 24 times the conduit diameter. Conduit sections shall be joined in accordance with the manufacturers' recommendations and shall be watertight.
2. Conduits entering pull boxes shall be capped or sealed watertight. Conduits entering access concrete manholes and vaults shall be terminated with flush end bells. Provide bushings on ends of conduits entering pull boxes.
3. Annular spaces around the conduit and precast unit walls shall be grouted. Bedding and backfill shall be as specified for the pipeline trench.
4. Not used.
5. Provide identification tape above underground conduit along the entire length of the conduit route
6. Provide and install fiber cable identification tags in each access vault, pullbox, and/or vault
7. Tracer wire shall be installed in the trench with fiber optic cable conduit and at pullbox / manholes with ten feet of tracer wire coiled and secured as specified herein.

B. Pull Box Installation:
1. Pull boxes shall be installed on a compacted level foundation consisting of 4 inches of granular material. Backfilling around pull boxes shall not be done until mortar sealant has thoroughly set.
2. Install the pull box covers with the top of the cover flush with the finished grade. Install pull boxes in soil areas with top of the cover 3 inches above the final grade level of the restored surface to prevent accumulation of dirt, silt and debris on the top of the cover. Perform conduit integrity tests for each section between the pull boxes after backfilling and compaction using the test and procedures described in this Section, prior to installation of the pull rope.
3. Pull boxes shall be free of debris and water, ready for cable installation upon final acceptance of the conduit system. Pull box conduit entries shall be sealed with grout to prevent the intrusion of water and debris into the pull boxes. Use red urethane: Greybar catalog #02044 or equal.

C. Conduit System Cleaning And Testing:
1. Conduits shall be cleaned of loose material by brush and compressed air following the backfill placement and compaction. Provide a test mandrel approximately 3/8 inch smaller than the inside diameter to be passed through conduits to detect alignment and deformation problems. Remove and replace conduit that fails the mandrel test. The replacement conduit shall then be cleaned and tested as described herein.
2. Cleaning and testing of the conduit shall be witnessed by the Construction Manager for conduit sections between adjacent pull boxes or manholes for the entire conduit route. Provide 5-day advance notice of the schedule and test location to the Construction Manager.

D. Not used.
1. Develop an innerduct pulling plan with proposed pull points, the direction of the pull, and the equipment with raceway lengths and bends included.
2. Verify routes and pull distances using the drawings and by field inspection.

3. Perform the pull tension calculations during the development of the pull plan and submit with the plan for approval not later than 30 days prior to installation.

E. Not used.

F. Not used.

3.02 FIBER OPTIC SYSTEM

A. Fiber Optic Cable Installation and Splicing Plan:
   1. Submit 30 days prior to cable installation.
   2. Air assisted cable placement method using high speed air blowing, push-pull, cable jetting plan with the procedure, the equipment setup, and a work plan.
   3. Work plan shall include the following:
      a. Pull tension calculations.
      b. Indicate additional pull boxes required, including station number and a written description of the location.
      c. Detailed description of pull operation methods for raceways.
      d. Tools and equipment for cable installation and testing
      e. Physical location of equipment setup and type
      f. Exact location of splice points
      g. Safety Plan and cable pulling operations
      h. Detailed schedule for pulling and testing cables

B. Fiber Optic Cable Installation:
   1. Fiber optic cable handling and storage shall be performed in accordance with the manufacturer’s recommendations. The cable installation personnel shall be experienced with specific knowledge of the cable manufacturer's recommended procedures. Cable reel lagging shall remain on the cable reels until they arrive at the installation site. If the lagging has been removed, securely fasten the cable ends to avoid damage during transit. The cable shall not be left exposed or unattended during the installation process. Verify cable is not damaged during storage and installation.
   2. Cable tension shall not exceed the manufacturer’s specification for tensile loading. Pulling tension shall be continuously monitored and recorded during installation. Fiber cable shall be pulled in a steady continuous manner. The bending radius of the cable shall not be exceeded. Cable tension monitoring devices shall not exceed cable pull tension and bend limits.
   3. Cable shall be installed in continuous lengths without intermediate splices. Cable shall be provided without splices except as shown on the plans. If additional splices are required, advanced approval of the Construction Manager shall be obtained.
   4. Additional cable shall extend to the nearest clean and level work area. Coils shall measure 100 feet for splice work locations.
   5. Cable strength elements shall be properly attached to a pulling eye and 600 lb breakaway swivel. Kellums pulling grips are not allowed except for short-length hand pulls.

6. Cable and conduits shall be lubricated during the pulling procedures. Each pullbox / concrete manhole / vault shall contain cable coiled into a slack loop and stored in a slack enclosure.
7. Tensile and bending limitation shall not be exceeded when power equipment is used to install cables. Tension monitoring shall use commercial dynamometers or load-cell instruments with chart recorder. Large diameter wheels, pulling sheaves, and cable guides shall maintain the specified bending radius.
8. Cable shall be installed using a hydraulic capstan or winch equipped with a recording running line dynamometer graph which measures and records pulling tensions. Provide Polywater Type 5 lubricant, or equal.
9. Cable pull records shall be documented by a graph which is annotated with the following information:
    a. Reel number.
    b. Station or pullbox from and station or pullbox to.
    c. Date and time.
    d. Explanations for abnormalities in readings or interruptions.
    e. Sign-off by Contractor and Construction Manager.
    f. Submit fiber optic pull records as specified herein.
10. Racking shall conform to the following:
    a. Loosely secure innerduct/cables in racked position with Ty-Raps or equal.
    b. Attach imprinted plastic coated cloth identification/warning tags to the innerduct/cable in at least two locations in each pullbox/concrete manhole/vault.
    c. Provide tags manufactured by Brady or Thomas & Betts.
11. Protect coiled cable to prevent damage to the cable and fibers with racking securing cables to brackets and racking hardware that extend from the sidewalls of the handhole. When cables are securely racked, unused conduits and void areas around conduit containing cables shall be sealed. In concrete manholes and vaults, coiled cable shall be placed into a slack enclosure to prevent damage to the cable and fibers.
12. Provide Semco compound or equal material.

C. Fiber Optic Cable Splicing and Terminations:
1. Prior to beginning the splicing, provide a work area to protect the cable splices from physical damage.
2. Work shall be performed by trained and FOA certified technicians and in accordance with the manufacturer's recommendations in the performance of installation, splicing and termination work.
3. Active and spare fiber optic cables fibers shall be provided with a breakout kit, and terminated with ST type terminations.
4. Splices shall have a loss no greater than 0.15 dB, as determined by either a Profile Alignment System (PAS) or Light Injection (LID) splice loss estimate, at the time the splice is made. Splices with an optical loss of greater than 0.15 dB shall be redone.
5. Indoor splices shall be mounted in a splice tray and the splice trays may be stored in either a separate indoor rack mounted splice module or within the patch panel. Outdoor splices shall be in an outdoor splice NEMA 3R or NEMA 4X enclosure as shown.

3.03 FIBER OPTIC TESTING:

A. The Construction Manager shall be notified a minimum of 5 days prior to tests and reserve the right to witness field tests.

B. Test Equipment:
   1. Test equipment shall be traceable to NIST standards. Use the following to perform the pre-installation and post-installation cable tests:
   2. Optical time domain reflectometer (OTDR) shall be laser precision, ALT, Inc. Model 5200 LRFL or equal.

C. Pre-Installation Tests:
   1. Perform acceptance tests on the cable prior to installation to verify that the cable conforms to the manufacturer's specifications, and is free of defects, breaks and damages by transportation and manufacturing processes. Perform tests on all reels of cable. Cable shall not be installed until the Construction Manager has reviewed the test report.
   2. Verify continuity and attenuation or loss for each fiber on each reel and document results of physical inspections to identify any cable and reel damage conditions, and any deviations from the manufacturer's specifications.
   3. Notify the Construction Manager 5 days prior to tests. Document test results and submit the report to the Construction Manager for review. Documentation shall consist of both hard copy and electronic disk complete with application software.

D. Post-Installation Tests:
   1. OTDR: Conduct the following tests on each cable segment with an OTDR each optical fiber in the fiber cable. Tests shall be conducted at both 1310 and 1550 nm. No splice loss shall have a loss of 0.15 dB or greater with fiber attenuation measured in dB/km.
   2. Excess Fiber Coefficient (EFC) Test shall be made as part of the cable testing. The following procedure shall be performed from both ends on each fiber provided.
      a. Prior to stripping the cable for splicing, record the meter marks to determine the physical cable length.
      b. Record the fiber Index of Refraction (IOR) from the cable data submitted by the Manufacturer.
      c. With the OTDR, set to the proper IOR and record the OTDR fiber length.
      d. Calculate the excess fiber coefficient (EFC) according to the following formula: EFC = OTDR length/Sheath length.

3. OLTS Fiber Attenuation: Measure the attenuation of each optical fiber in both directions using a with an Optical Loss Test Set (OLTS) at both 1310 nm and 1550 nm. Test shall be conducted per TIA/EIA 526-7. Provide a reference power level measured with a patch cord and connectors of the same types used on the fiber cable. Measure and record the reference power level of the Laser Light Source. Measure and record the received power level of each optical. Repeat the same measurements in the other direction.
    a. The measured insertion loss shall be no greater than the loss calculated in the formula below:

       IL = 2(Ls) + 2(Lc) + (La)(Length) + 0.5

       where:

       IL = Insertion Loss
       Ls = Splice losses at the pigtails (maximum 0.15 dB)
       Lc = Connector face loss (maximum 0.6 dB)
       La = Manufacturer's cable attenuation (dB/km)
       Length = Fiber length (km)

E. Cable Acceptance:
    1. Pigtail splices shall have a loss no greater than 0.15 dB, as determined by either a Profile Alignment System (PAS) or Light Injection (LID) splice loss estimate, at the time the splice is made. Splices with an optical loss of greater than 0.15 dB shall be redone.
    2. OTDR traces at both 1310 nm and 1550 nm wavelengths display no unexplained losses, reflectance events, or other discontinuities.
    3. The insertion losses measured at both 1310 nm and 1550 nm wavelengths and in both directions do not exceed the maximum allowed values. After cable tests, the cable installation shall be subject to a physical inspection to verify the remaining fiber optic specification requirements have been met. If any test requirements are not met, or in the event of fiber test failure of one or more fibers, splice or replace cable as necessary until tests pass.

F. Fiber Optic System Acceptance:
    1. Perform the inspection and establish a punch-list of the following:
        a. Fiber splices: neatly organized.
        b. Connectors: capped and undamaged.
        c. Cabling: organized with no excessive bending.
        d. Specified coiled cable present in the splice cabinet.
        e. Cable entrances to the cabinets secured.
        f. Unused cable delivered to the Owner.
    2. Identify cables with the directories installed in each fiber cabinet. Discrepancies found during the inspection of the fiber system installation shall be listed and provided on the punch-list. Inform the Construction Manager upon resolution and completion of the punch-list items.

3.04 CABLE SPECIFICATION SHEETS (CABLESPEC)

A. General:
   1. Cable types for different locations, service conditions and raceway systems are specified on individual cable specification sheets. Cables that are scheduled herein shall be installed in accordance with the CABLESPEC SHEETS.
   2. Single mode fiber optic cables shall meet the requirements of the referenced ANSI, ICEA, ITU, TIA, and EIA standards for outside plant data communications cable.

B. CABLESPEC Sheets:
   1. The following CABLESPEC sheets are included in this section:

Type	Volt	Product	Purpose
FOC-SM	300	Fiber Optic Cable Indoor/Outdoor	Data Communication

3.05 CABLE SPECIFICATION SHEET—CABLESPEC – FOC-SM

A. Cable System Identification:
   1. FOC-SM.

B. Description:
   1. Single Mode Fiber Optic Data Cable; 6-pair fiber conductor:
   2. Outdoor; Heavy Duty-MFPT; Cable Tray Rated.
   3. Loose tube construction. Optical fibers shall not adhere to the inside of the buffer tube.
   4. Fibers and buffer tubes shall be color coded with distinct and recognizable colors in accordance with EIA/TIA-598-B.

C. Material:
   1. 8.2/125/250 micron.

D. Jacket:
   1. Chlorinated Polyethylene (CPE) Color: Yellow or Black.
   2. Mark the exterior sheathing with the manufacturer's name, month and year of manufacture, and sequential meter or foot markings for easily determining the length of the cable at all points along the cable run.
   3. Provide a telecommunication handset symbol as required by Section 350G of the National Electrical Safety Code® (NESC®), fiber count, and fiber type.

E. Type:
   1. OFNR with industrial cable tray rating and IEEE flame test rated: 802.3Z.
   2. Fiber Type: Single Mode.
   3. Clad Diameter: 125 ± 0.7 µm.
   4. Coating Diameter: 245 ± 5 µm.
   5. Core Diameter: 8.2 µm.

6. Attenuation:
   a. ≤ 0.35 db/km @ 1310 nm.
   b. ≤ 0.25 db/km @ 1550 nm.
7. Operating Temperature Range: -40 to +70 Deg C.
8. Maximum Tensile Loading: 600 lbf.
9. Minimum Cable Bending Radius: 10 x diameter.

F. Manufacturers:
1. Corning Cable Systems.
2. Alcoa Fujikura.
3. Corning SMF-28e fiber.
4. Or approved equal.

G. Execution:
1. Application: Data Communications.
2. Installation: Install in accordance with manufacturers instructions and as specified.
3. Testing: Test as specified above.

END OF SECTION

SECTION 31 10 00

SITE CLEARING

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope: This section specifies site preparation which consists of clearing and grubbing

B. Existing Conditions: The Contractor shall determine the actual condition of each site as it affects this portion of work.

C. Protection: Site preparation shall not damage structures, landscaping or vegetation adjacent to the site. The Contractor shall repair, or replace any damaged property.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 CLEARING AND GRUBBING

A. Unless otherwise specified, the Contractor shall remove obstructions such as brush, trees, logs, stumps, roots, heavy sod, vegetation, rock, stones larger than 6 inches in any dimension, broken or old concrete and pavement, debris, and structures where the completion of the work require their removal.

B. Material that is removed and is not to be incorporated in the work shall be disposed of off the site.

END OF SECTION

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SECTION 31 21 33

TRENCHING, BACKFILLING, AND COMPACTING FOR UTILITIES

PART 1 GENERAL

1.01 SUMMARY

A. Section specifies excavation, trenching, backfilling and compacting for underground utilities and appurtenances.

B. The CONTRACTOR shall provide all labor, materials, equipment, supervision, and testing necessary to construct the improvements.

C. Excavating, trenching, bedding and backfill shall be performed as specified herein and in accordance with the requirements of the Agency with jurisdiction over the rights-of-way in which the Work is performed. In the case of conflict between the Agency's requirements and these specifications, the requirements affording the greatest protection to the OWNER shall apply, as determined by the CONSTRUCTION MANAGER.

D. Work must be performed in accordance with OSHA and all local, state and federal requirements.

1.02 REFERENCES

A. Referenced Standards: This Section incorporates by reference the latest revision of the following documents. These references are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

1. ASTM International (ASTM):
    a. C33, Standard Specification for Concrete Aggregates.
    b. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3).
    c. D2487, Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
    d. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
    e. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
    f. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil Aggregate by Nuclear Method (Shallow Method).

1.03 QUALIFICATIONS:

A. Hire an independent ADOT certified soils laboratory to conduct source materials testing and compaction testing.

1.04 SUBMITTALS

A. Procedures: Section 01 33 00 Submittal Procedures.

B. Product technical data per Section 31 23 00, Earthwork.

C. Contractor's Safety Plan for personnel.

D. Contractor-obtained permits.

E. Qualifications: Name(s) and qualifications of trenching and excavation Competent Person(s). To qualify as a Competent Person, he or she shall have completed the equivalent of 10-hour Arizona OSHA (ADOSH) Construction Safety Training within the last five (5) years.

F. The following information shall be provided prior to beginning Work:
   1. Excavation sheeting, shoring, and bracing system design in accordance with Section 33 05 25.
   2. Qualification information of excavation support system designer (Professional Engineer registered in the State of Arizona) in accordance with Section 33 05 25.

G. Submit report from a testing laboratory verifying that material conforms to the specified gradations or characteristics for pipe zone and trench backfill material including sand, rock refill for foundation stabilization, and water. Include laboratory moisture-density relations of soils.

H. Submit method of compaction in pipe zone including removal sequence of shoring where used.

I. Submit mix designs for controlled low strength material (CLSM, aka flowable fill). Comply with CLSM cold weather placement as specified herein.

J. Submit excavation plans for worker protection and dewatering plans.

1.05 SITE CONDITIONS

A. Plan for and provide work zone traffic control to meet ADOT and governing local agency requirements.

B. Avoid overloading or surcharge a sufficient distance back from edge of excavation to prevent slides or caving.

C. Maintain and trim excavated materials in such manner to be as little inconvenience as possible to public and adjoining property owners.

D. Provide full access to public and private premises to prevent interruption of travel.

E. Protect and maintain benchmarks, monuments or other established points and reference points and if disturbed or destroyed, replace items to full satisfaction of the Owner and controlling agency.

F. Verify location of existing underground utilities and comply with the rules of the Blue Stakes of Arizona 811.

1.06 TESTING FOR COMPACTION

A. Test for compaction as described in Section 31 23 00, Earthwork.

B. Where compaction tests indicate a failure to meet the specified compaction, the Contractor shall take additional tests every 10 feet in each direction until the extent of the failing area is identified. Rework the entire failed area until the specified compaction has been achieved.

1.07 DEFINITIONS

A. PAVEMENT ZONE

1. The pavement zone includes the asphalt concrete and aggregate base pavement section placed over the street zone.

B. ROAD ZONE OR STREET ZONE

1. The road zone (street zone) is the top 12 inches of the trench immediately below the pavement zone in paved areas.

C. TRENCH ZONE

1. The trench zone includes the portion of the trench from the top of the pipe zone to the bottom of the street zone in paved areas or to the existing surface in unpaved areas or 6 inches below existing or finished grade where topsoil is required, unless noted otherwise.

D. PIPE ZONE

1. Unless noted otherwise, the pipe zone shall include the full width of trench from the bottom of the pipe base or bedding to a horizontal level above the top of the pipe, as specified below. Where multiple pipes or conduits are placed in the same trench, the pipe zone shall extend from the bottom of the lowest pipes to a horizontal level above the top of the highest or topmost pipe. Thickness of pipe zone above the highest top of pipe shall be as follows unless otherwise shown on Drawings or otherwise described in the Specifications for the particular type of pipe installed. For electric ducts and duct banks, trench wall clearances and pipe zone dimensions are shown on Drawings.

Pipe Diameter	Thickness of Pipe Zone Above Top of Pipe
6 inches or smaller	6 inches
8 inches and larger	12 inches

E. PIPE BASE OR BEDDING

1. The pipe base or bedding shall be defined as a layer of material immediately below the bottom of the pipe or conduit and extending across the full trench width in which the pipe is bedded. Thickness of pipe base shall be as follows unless otherwise shown on Drawings or otherwise described in the specifications for the particular type of pipe installed.

Pipe Diameter	Thickness of Pipe Base Below Bottom of Pipe
12 inches and smaller	4 inches
14 inches and larger	6 inches

PART 2 PRODUCTS

2.01 MATERIALS

A. Per Section 31 23 00, Earthwork.

B. Marking tape:
   1. Marking Tape (Nondetectable):
      a. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
      b. Thickness: Minimum 4 mils.
      c. Width: 12 inches.
      d. Color: Blue (for water) and Orange for Cathodic Protection test wires.
      e. Lettering: Minimum 1-inch high, permanent black lettering imprint continuously over entire length.
         1) Text shall be: “High Pressure Waterline Buried Below” for water and “WBWCD CP Test Wires” for cathodic protection wire.
         2) Provide over other utilities exposed if utility owner requires.
         3) Provide over WBWCD cathodic protection wires.
      f. Manufacturers and Products:
         1) Reef Industries; Terra Tape.
         2) Allen; Markline.

PART 3 EXECUTION

3.01 GENERAL

A. Excavate and dispose of all materials of whatever nature encountered, including all obstructions that would interfere with the proper execution and completion of the Work. The removal of these materials shall conform to the lines and grades indicated or ordered.

B. Shoring system designer shall certify in writing that the excavation support systems are constructed per the applicable stamped, dated, and signed excavation support system of the designer including any modifications by Contractor during construction.

3.02 PROTECTION

A. Protect existing surface and subsurface features on-site and adjacent to site. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing items indicated to remain in place.

B. Protect existing utilities from damage or disturbance. Immediately notify utility whose facilities have been damage or disturbed. At utility owner’s option, repair damaged utility or compensate utility owner for completed repairs.

C. Perform trenching and excavating operations in such a manner to protect personnel and the public from the dangers associated with trenching and excavation.

3.03 EXCAVATION

A. Follow applicable health and safety OSHA standards and requirements.

B. Remove rock, soil, organics, pavement, hard pan, loose shale, loose stone, and other obstructions as required to completed the Work or as directed by the Construction Manager.

C. Trench Excavation:
   1. All excavation for pipelines and structures shall be done to the dimensions and levels indicated on the Drawings or specified herein. Excavate to such width outside the lines of the pipeline and structure to be constructed as may be required for proper working methods, the erection of forms and the protection of the Work.
   2. Take care to preserve the native subgrade surfaces in an undisturbed condition. If the Contractor over excavates or disturbs the subgrade surfaces, without written authorization of the Construction Manager, Contractor shall replace such subgrade material with material approved by the Construction Manager in a manner that will show by test an equal subgrade or foundation bearing value with the undisturbed foundation material. No additional payment will be made for the added quantity of materials used because of over excavation.
   3. Inspection of Excavation: Notify the Construction Manager when excavation for the pipeline structure is complete. No geotextiles, imported material layers, forms, reinforcing steel, concrete, or precast structure shall be placed until the excavation subgrade and subsequent import material compacted surfaces have been inspected by the Construction Manager.
   4. Where unsatisfactory material is encountered at the subgrade level below the pipe and structural excavations, it shall be removed and replaced as directed by the Construction Manager and compacted as specified. Payment for removal and replacement of such unsatisfactory material directed by the Construction Manager shall be made in accordance with the appropriate provisions of the Contract Documents.
   5. Perform all excavation regardless of type, groundwater or other conditions per Section 31 23 00, Earthwork. Excavate the trench to the lines and grades shown on Drawings with allowance for pipe thickness, sheeting and shoring if used, and for pipe base or special bedding. If the trench is excavated beyond (horizontally or vertically) that required on Drawings and Specifications, refill any part of the over-excavated trench at no additional cost to the Owner with the same material required in the plans and specs, or foundation stabilization material, where required by the Construction Manager.
   6. Excavate trenches by open cut method (when possible) to depth shown on Drawings and necessary to accommodate work.
      a. Verify location of utilities and protect as necessary.
      b. Support existing utility where proposed work crosses at a lower elevation.
      c. Stabilize excavation to prevent undermining of existing utility.
   7. Open trench limits:
      a. Limit length of open trench to no more than shown on the Drawings or specified.
      b. Reduce limits of open trench as weather conditions or groundwater infiltration dictate.

c. At Owner's discretion, any excavation, trench, or portion of a trench which is opened and remains idle, shall be backfilled, if directed by the Construction Manager.
    1) If backfilled at Construction Manager's direction, trench or excavation may not be reopened until Construction Manager is satisfied that work associated with the trench or excavation will be performed immediately.
d. Trenches left open must be protected from traffic and to prevent public access.
    1) Within unpaved areas limit the length of open trench to 500 feet in advance of pipe laying or the amount of pipe installed in one working day. Complete backfilling not more than 500 feet in the rear of pipe laying.
    2) Open trenches allowed within a traveled way (vehicular or pedestrian) or within 25 feet of a traveled way or occupied structure that is not barricaded off from the public traveled way using ADOT-approved jersey barriers shall be fully backfilled at the end of each day or covered with steel plates or other acceptable covers capable of supporting AASHTO HS-20 traffic loads. Maximum length of trench that may be covered with steel plates shall not exceed 200 feet.

8. Observe following trenching criteria:
    a. Trench size:
        1) Excavate width to provide adequate working room given the work area restrictions.
        2) Refer to drawings for trench maximum width dimensions. Comply with 29CFR Part 1926 Subpart P, Excavations. Trench width at the top of the trench will be limited to the width of the shoring for the excavation and should not undercut adjacent structures and footing. In such case, width of trench shall be such that there is at least 2 feet between the top edge of the trench and the structure or footing.
        3) Cut trench walls vertically from bottom of trench to minimum 1 foot above top of pipe.
        4) Keep trenches free of surface water runoff and groundwater seepage to a minimum 12 inches below the bottom of the trench, as required by Section 31 23 19, Dewatering.
9. Sloping, sheeting, shoring, and bracing of trenches:
    a. Trenches shall have sloping, sheeting, shoring, and bracing conforming with 29CFR1926, Subpart P - Excavations, OSHA requirements, and General Conditions.
    b. Provide shoring protection in accordance with Section 33 05 25, Excavation Support Systems.
        1) Shoring/bracing shall be designed and maintained so that soil does not migrate from behind the structural system creating voids. Shoring/bracing systems shall be removed such that compacted backfill is not disturbed.
        2) Address ground settlement and utility shearing/settlement during installation and removal of shoring. If shoring methods are damaging utilities or services, change shoring methods or provide alternate construction methods so utilities and services are in acceptable and functional condition during and after construction.

10. Trench excavation in backfill and embankment areas:
    a. Conduct trenching in fill areas after primary settlement is achieved and rough grading completed.
    b. Where top of pipe is above existing grade, place and compact fills to 12 inches above top of pipe before excavating trench. Fills above top of pipe may be placed after pipe installation.
    c. Excavate trench in the compacted backfill or embankment. Place pipe base material, install pipe or conduit, and backfill with pipe zone material. Compact backfill above the pipe zone to the same relative compaction as the adjacent embankment as specified in Section 31 23 00, Earthwork.
11. Location of excavated material:
    a. See Drawings for designated stockpile areas.
    b. During trench excavation, place the excavated material only within the working area or within the construction and permanent easements and stockpile areas shown on Drawings unless letters of authorization from land owners (and land owner signed release forms at the end of the Project) are submitted to the Construction Manager authorizing work outside construction limits.
    c. Locate stockpiles for excavated trench materials outside of street rights of way. Do not obstruct any roadways or streets. Conform to federal, state, and local codes governing the safe loading of trenches with excavated material.
    d. Excavated topsoil shall be removed and stored separately. Unless otherwise noted, replace topsoil in the top 6 inches of the trench zone. Strip, stockpile, and spread existing top soils per ADOT Standard Specifications.
    e. Trench spoil piles shall be located at least 5 feet from the tops of the slopes of trenches. Cranes and other equipment shall not be operated on the same side of the trench as the spoil piles.
    f. Where natural cross-slopes exceed 15 degrees, trench spoil shall not be located uphill of the excavation unless stability is assessed through analysis by a registered professional engineer and authorized by the Construction Manager.
    g. Dispose of excess excavated native trench materials per Section 31 23 00, Earthwork.

3.04 PREPARATION OF FOUNDATION FOR PIPE LAYING

A. Regular Trench Excavation:
    1. Excavate minimum of 6 inches below bottom exterior surface of the pipe.
    2. Remove soft, loose, or previously disturbed or otherwise unsuitable material or soil from the bottom of the trench.
    3. Install pipe bedding material.
    4. Form welder access holes in trench bottom (where required).
    5. Support pipe.

B. Over-Excavation and Subgrade Stabilization:
    1. Observe the following requirements when unstable trench bottom materials are encountered.
        a. Notify Construction Manager when unstable materials are encountered.
        b. Remove unstable trench bottom.

c. Backfill to the grade of the bottom of the pipe bedding with flowable fill material and compact.

2. Any over-excavation carried below the grade ordered or indicated or if caused by Contractor's operations or failure to dewater or maintain a dry trench, shall be performed by the Contractor at no additional cost to the Owner.
3. Over excavation, if field-initiated by Construction Manager, shall include the removal of all material that exists directly beneath the pipeline to a width 24 inches (minimum) greater than the pipe outside diameter and to the depth required.
   a. Backfill the trench to subgrade of pipe base with rock refill material for foundation stabilization. Place the foundation stabilization material over the full width of the trench and compact in layers not exceeding 8 inches deep to the required grade. Compact each layer with a track-hoe roller head to the satisfaction of the Construction Manager. Rock refill used by the Contractor for his/her convenience will not receive any additional payment.
   b. Where over excavation and rock refill are not required on Drawings, foundation stabilization work shall be executed only by change order when unacceptably soft (as determined by the Construction manager) subgrade materials are encountered in the trench. In such areas, after the required excavation has been completed, the Construction Manager will inspect the exposed subgrade to determine the need for any additional excavation. It is the intent that additional excavation be conducted in all areas within the influence of the pipeline where unacceptable materials exist at the exposed subgrade.

3.05 INSTALLING BURIED PIPING

A. Store, handle, and install pipe per Section 33 05 25, and per the detailed piping specifications for the particular type of pipe, and per the following:
   1. Handle pipe in such a manner as to avoid damage to the pipe. Do not drop or dump pipe into trenches under any circumstances.
   2. Inspect each pipe and fitting before lowering the buried pipe or fitting into the trench. Inspect the interior and exterior protective coatings. Patch damaged areas in the field with material recommended by the protective coating manufacturer. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after installation.

B. Grade trench bottom to line and grade allowing for pipe thickness and bedding. Remove hard spots that would prevent a uniform bedding thickness. Place specified bedding thickness over full trench width. Grade and compact the top of bedding before pipelaying to provide firm, continuous, uniform support along full pipe length, and compact to the relative compaction specified. Before laying each section of the pipe, check the grade with a straightedge and correct any irregularities.

C. Excavate bell hole at each joint to permit proper assembly and inspection of entire joint.

D. Line and Grade: As shown on the Drawings.

E. After pipe has been bedded, place pipe zone material simultaneously on both sides of the pipe, in maximum 8-inch lifts, keeping the level of backfill the same on each side. Carefully place the material around the pipe so that the pipe barrel is completely supported and that no voids or uncompacted areas are left beneath the pipe. Use particular care in placing material on the underside of the pipe to prevent lateral movement during subsequent backfilling.

F. Compact each lift to the relative compaction specified herein. Compact trench backfill to the specified relative compaction. Compact by using mechanical compaction, or hand tamping.
   1. Compact material placed within 12 inches of the outer surface of the pipe by hand operated tampers or other equipment that will not damage the pipe.
   2. Do not use any axle-driven or tractor-drawn compaction equipment within 5 feet of building walls, foundations, and other structures.

G. Push the backfill material carefully onto the backfill previously placed in the pipe zone. Do not permit free fall of the material until at least 2 feet of cover is provided over the top of the pipe. Do not drop sharp, heavy pieces of material directly onto the pipe or the tamped material around the pipe. Do not operate heavy equipment over the pipe until at least 3 feet of backfill has been placed and compacted over the pipe.

H. When the pipelaying is not in progress, including the noon hours, close the open ends of pipe. Do not allow trench water, animals, or foreign material to enter the pipe.

I. Remove and dispose of all water entering the trench during the process of pipelaying. Keep the trench dry until the pipelaying and jointing are completed.

J. To avoid jarring pipe off grade, after setting (surveying) pipe to grade, do not MOVE shoring until after joint welding, coating and initial CLSM pipe zone set. After initial set, lift shoring panels to fill all shoring voids with CLSM and bring up backfill uniformly on both side of the pipe.

3.06 BACKFILLING METHODS

A. Do not backfill until tests to be performed on pipe show system is in full compliance with specifications.

B. Backfill shall be placed after all water is removed from the excavation, and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction.

C. Lift trench shields and trench boxes during placement of backfill. Ensure that each lift of backfill material makes full contact with earth trench sides prior to compacting the lift of backfill.

D. Pipe Zone:
   1. The CONTRACTOR shall not proceed with bedding placement or pipe installation in excavated areas until the subgrade has been inspected.
   2. Bedding material shall be placed in the bottom of the trench, leveled and compacted over the full width of the trench. Grade the top of the bedding ahead of the pipe laying to provide a firm, uniform support along the full length of pipe.

3. Backfill material shall be carefully placed and compacted around the pipe to ensure the pipe barrel is completely supported and that no voids or uncompacted areas are left beneath the pipe or below the haunches. Fill material shall be placed simultaneously on both sides of the pipe, keeping the level of backfill the same on each side.
4. Backfill around and over pipe shall be compacted using light hand operated, vibratory compactors and rollers. The use of a jetting and backhoe mounted compaction wheel is prohibited within the pipe zone above the top of the pipe. Care shall be exercised in placing material to prevent movement of the pipe during backfilling and to prevent gouging, denting or crushing of pipe or laterals.
5. Contractor shall be responsible for properly protecting pipe and appurtenances during backfill operations utilizing flowable backfill and providing measures as approved by the Construction Manager to prevent flotation.
6. Avoid displacing pipe joints and appurtenances or causing any horizontal or vertical misalignment, separation, or distortion.
7. Comply with pipe manufacturer's recommendations regarding backfilling and compaction.

E. Trench Zone and Final Backfill:
1. After the Pipe Zone material has been placed, compacted, inspected and accepted by the Construction Manager, backfill in the Trench Zone may proceed.
2. Care shall be exercised in the moving or removal of trench supports to prevent the caving or collapse of the excavation face. Voids between the native material, bedding and backfill must be filled and compacted to the satisfaction of the Construction Manager, ADOT, or Agency with jurisdiction of the right-of-way.
3. Place backfill in lift thicknesses capable of being compacted to density specified, but in no case exceeding 18-inch loose thickness.
4. Comply with pipe manufacturer's recommendations regarding backfilling and compaction.
5. Avoid displacing pipe joints and appurtenances or causing any horizontal or vertical misalignment, separation, or distortion.
6. Backfill to finished grade as shown on the Drawings and as follows:
    a. In paved areas, backfill shall be placed in accordance with requirements for pavement restoration.
    b. In unpaved or landscaped area, place topsoil as necessary to maintain the surface of the backfilled trench level with the adjacent ground surface.

F. Water flushing for consolidation is not permitted unless allowed in writing from Construction Manager.

G. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or as backfill material is being placed and compacted and then moving the shield horizontally. Do not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.

H. Cold weather limitations in placing fill and backfill
   1. Unless allowed in the authorized Cold Weather Construction Plan, earth fills and backfills requiring 95 percent or higher relative compaction shall not be placed when either atmospheric temperature, or the temperature of the existing ground or the fill being placed, are below 35 degrees Fahrenheit unless both the existing ground and the fill being placed are both non-frost susceptible materials.
   2. Earth fills and backfills requiring 90 percent or lower relative compaction may be placed when temperatures are below 35 degrees Fahrenheit if the required compaction is achieved. If the required compaction is not achieved, the work shall be removed and re-compacted.
   3. Do not place any fill or backfill materials which require 95 percent, or higher, relative compaction if the excavation or subgrade contains frozen moisture (snow, ice, sleet, etc.), frozen earthen materials, or earthen materials which have been deposited in the excavation due to freezing, thawing, precipitation, or other inappropriate means.
   4. Do not place fill materials which contain frozen moisture (snow, ice, sleet, etc.) except as allowed in the paragraphs above.
   5. Work performed outside the required temperature limitations is subject to rejection, removal and replacement.

I. Remove and replace any trenching and backfilling material which does not meet the Specifications, at the Contractor's expense.

3.07 COMPACTION REQUIREMENTS

A. Unless otherwise shown on Drawings or otherwise described in the Specifications for the particular type of pipe installed, relative compaction in pipe trenches shall be as follows (relative compaction values are per ASTM D1557 and per Section 31 23 00, Earthwork):
   1. Pipe Bedding (except CLSM): 90 percent relative compaction.
   2. Pipe Zone (except CLSM): 90 percent relative compaction.
   3. Backfill in Trench Zone not Beneath Paving: 95 percent relative compaction.
   4. Backfill in Trench Zone and Street Zone in Paved Areas: 95 percent relative compaction.
   5. Backfill in Pavement Zone under Asphalt: 95 percent relative compaction.
   6. Rock Refill for Contractor Over-excavation and for Foundation Stabilization: With a track-hoe roller head to the satisfaction of the Construction Manager.
   7. Topsoil Replaced: Match density of adjacent topsoil.
   8. Beneath Vaults, Manholes, and Other Structures: 95 percent relative compaction.
   9. All backfill placed soil for compaction shall be between 4 percent below and 2 percent above optimum moisture content unless noted otherwise.

3.08 PLACEMENT OF CLSM – NOT USED

3.09 INSTALLING MARKING TAPE

A. Install marking tape where shown in the trench details on Drawings. Secure marking tape to prevent movement during backfill. Marking tape is required over fiber optic ducts, water pipes, and cathodic test wires.

3.10 FIELD QUALITY ASSURANCE

A. Materials Testing:

1. The Contractor shall perform and be responsible for all sampling and testing of materials as required for quality assurance/control of the Work. The Contractor shall pay for all costs associated with the day-to-day quality assurance/control to maintain all material within specified or approved limits. The Contractor shall retain a registered geotechnical engineer, independent from the Contractor, and a testing laboratory, whose qualifications are each acceptable to the Construction Manager by submittal, to perform all compliance testing described below. The Construction Manager may have an independent testing laboratory perform additional tests at no cost to the Contractor, however the Contractor shall provide materials for testing at no additional cost to the Owner.
2. Perform particle size analysis of soils and aggregates in accordance with ASTM C 136 Sieve Analysis of Fine and Coarse Aggregate and ASTM C 117 Materials Finer than No. 200 Sieve in Mineral Aggregate by Washing.
3. Determine sand equivalent in accordance with ASTM D 2419. Unified Soil Classification System: References to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487. The Contractor shall be bound by all applicable provisions of ASTM D 2487 in the interpretation of soil classifications.
4. Where soil material is required to be compacted to a percentage of maximum dry density, the maximum dry density at optimum moisture content will be determined in accordance with ASTM D 1557. In the field, determine the density of soil in place by the sand cone method, ASTM D 1556 or by nuclear methods, ASTM D 6938 and D 3017.
5. Apply rock correction factors as applicable. In case the test of the fill or backfill shows non-compliance with the required density, perform remedies as may be required to insure compliance. Subsequent testing to show compliance shall be by a testing laboratory selected by the Construction Manager and paid for by the Contractor.
6. Compaction tests shall be performed for each lift or layer. If nuclear methods are used for in-place density determination, verify the accuracy with one sand cone test, and one maximum laboratory dry density test, for every 2 weeks nuclear tests are used if the backfill material is processed fill or visually consistent. The Construction Manager shall be the sole judge of visual consistency. More sand cone and dry density tests will be required if the backfill material is visually variable. The minimum depth for the sand cone test hole shall be 12 inches. The minimum size shall be 8 inches and size 16/30 or 10/20 silica sand shall be used.
7. Determine laboratory moisture-density relations of soils by ASTM D 1557. If nuclear methods are used for in-place density determination, the compaction test results for maximum dry density and optimum water content shall be adjusted in accordance with ASTM D 4718. This will be required for determination of percent relative compaction and moisture variation from optimum.
8. Determine the relative density of cohesion-less soils by ASTM D 4253 and D 4254. Sample backfill materials by ASTM D 75. "Relative Compaction" is the ratio, expressed as a percentage, of the in-place dry density to the laboratory maximum dry density.

B. Testing Frequency:
   1. After an acceptable compaction procedure is established, compaction tests shall be taken at 300-foot intervals along the trench and at vertical intervals for every other lift at random locations and not necessarily vertical in line. A minimum of two tests will be required for each production day in the trench. Tests shall also be taken near structures, manholes, etc., and where designated by the Construction Manager. Embankment and fill areas shall have at least one compaction test performed each production day and no fewer than one test for each 1,000 cubic yards. Copies of all test reports shall be submitted to the Construction Manager by the next working day.
   2. Location for compaction tests shall be prepared and submitted to the Construction Manager for approval prior to testing.
   3. Compaction and other tests may be taken by the Construction Manager at intervals along the trench as described above to verify compliance with these requirements. Accommodate the Construction Manager in conducting these tests. Provide access and exploratory excavation as required to collect samples or conduct tests. Allot sufficient time during construction for the performance of any such compaction testing.
   4. Compaction shall be deemed to comply with the specifications when no compaction test falls below the specified relative compaction. Pay the costs of any retesting of work not conforming to the specifications. Should the compaction methods used fail to achieve the required degree of compaction, revise compaction method to achieve the required compaction.
   5. If a compaction fails to meet the specified requirements, remove and replace the backfill at proper density or bring the density up to specified level by other means acceptable to the Construction Manager. Pay for all subsequent tests required to confirm and verify that the reconstructed backfill has been brought up to specified density. Frequency of confirmation tests for remedial work shall be double that amount specified for initial confirmation tests.

C. Costs associated with necessary corrective work resulting from failed tests or inspections shall be paid by Contractor. Should any originally scheduled quality assurance test or inspection fail to meet requirements of the Contract Documents, the Contractor shall be responsible for the cost of retesting or re-inspection of Work including inspector's and tester's time and trips.

D. Should any compaction density test or subgrade inspection fail to meet requirements, perform corrective work as necessary to bring the material into conformance with the requirement of the Contract Documents.

END OF SECTION

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SECTION 31 23 00

EARTHWORK

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies earthwork which consists of excavation, filling, grading, and disposal of excess material. This Section also specifies aggregate materials for a variety of uses including structural backfill, pipe bedding, backfill of trenches, flowable fill, and crushed rock aggregates for use under asphalt and as gravel road surfaces or road shoulders.

A. Definitions:
   1. Compaction: The degree of compaction is specified as percent compaction. Maximum or relative densities refer to dry soil densities obtainable at optimum moisture content.
   2. Excavation Slope: Excavation slope shall be defined as an inclined surface formed by removing material from below existing grade.
   3. Embankment Slope: Embankment slope shall be defined as an inclined surface formed by placement of material above existing grade.

1.02 QUALITY CONTROL AND ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C136	Standard Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D1556	Test Method for Density of Soil in Place by the Sand-Cone Method
ASTM D1557	Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.5-kg) Rammer and 18-in. (457-mm) Drop
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate

Reference	Title
ASTM D3017	Test Method for Moisture Content of Soil and Soil- Aggregate in Place by Nuclear Methods (Shallow Depth)
UDOT	2022 Standard Specification and Drawings for Road and Bridge Construction

B. Qualifications: Hire an independent ADOT certified soils laboratory to conduct materials testing that may be required to identify acceptable source materials, and to complete tests required for source material acceptance as part of the submittal process, such as initial grain size and plasticity tests.

C. Contractor shall provide and pay for Independent Testing for Quality Control and Assurance testing. The Contractor shall hire an independent ADOT certified soils testing agenct to take samples and perform moisture content, gradation, compaction, and density tests during placement of backfill materials to check compliance with these specifications. Tests shall be done in accordance with the followingA:

Test	Standard Procedure
Moisture content	ASTM D3017
Gradation	ASTM C136
Density in-place	ASTM D1556
Moisture-density relationships	ASTM D1557

1.03 SUBMITTALS

A. Procedures: Section 01 33 00, Submittal Procedures.

B. Submit a description and location of proposed sources of imported material.

C. Submit samples of all materials proposed to be used in the Work to demonstrate material conformance with these Specifications. Samples shall consist of 0.5 cubic feet of each type of material.

D. Test for conformance and submit certification and test records of all materials showing that they meet the applicable requirements. Obtain Construction Manager approval of test and certification submittals prior to placement of the materials for the Work.

E. Product technical data including:
   1. Acknowledgement that products submitted meet requirements of standards referenced.
   2. Certified test results: Including, but not limited to gradation analysis, moisture density relationships, and in-place density test result reports on all materials tested.
   3. Provide excavation support system submittal information in accordance with 33 05 25 and the following:
      a. Methods and sequencing of trench excavations.
      b. Proposed locations of stockpiled excavation and backfill material.
      c. Number, types, and sizes of equipment proposed to perform excavations.

1.04 SITE CONDITIONS

A. Plan for and provide work zone traffic control to meet ADOT and governing local agency requirements and the requirements provided in Section 01 55 26.

B. Avoid overloading or surcharge a sufficient distance back from edge of excavation to prevent slides or caving.

C. Maintain and trim excavated materials in such manner to be as little inconvenience as possible to public and adjoining property owners.

D. Protect and maintain benchmarks, monuments or other established points and reference points and if disturbed or destroyed, replace items to full satisfaction of Owner and controlling agency.

E. Verify location of existing underground utilities and comply with the rules of the Blue Stakes of Utah 811.

PART 2 PRODUCTS

2.01 MATERIALS

A. Type A:

1. Type A material shall be a clean cohesionless, granular, gravel-sand mixture free from organic matter and shall conform to the following gradation:

U.S. standard sieve size	Percent by weight passing
3/4 inch	100
½ inch	90-100
3/8 inch	40-70
No. 4	0-15
No. 80	0-5

2. The material shall be non-plastic as determined in accordance with ASTM 4318. The material shall be free from clay lumps or other deleterious materials.

B. Type B:

1. Type B material shall be a select granular material free from organic matter and of such size and gradation that the specified compaction can be readily attained. Material shall have a sand equivalent value determined in accordance with ASTM D2419 of not less than 20 and shall conform to the following gradation:

U.S. standard sieve size	Percent by weight passing
3 inch	100
¾ inch	70-100
No. 4	40-100
No. 200	15-50

2. The coefficient of uniformity shall be 3 or greater.

3. The plasticity index of the material as determined in accordance with ASTM D4318, shall not exceed 12.
4. The material shall be free froom clay lumps, rocks larger than 3 inches in any dimension, or other deleterious materials.
5. The material may be an imported quarry waste, clean natural sand or gravel, select trench excavation or a mixture thereof.

C. Type C:
1. Type C material shall consist of soil that conforms to the following characteristics:

U.S. standard sieve size	Percent by weight passing
No. 4	100
No. 200	0-25

2. The plasticity index of the material, as determined in accordance with ASTM D4318, shall not exceed 12.
3. This material shall be free from roots, grass, or other vegetable matter, clay lumps or other deleterious materials.

D. Type D:
1. Type D material shall be granular base material and shall conform to the following gradation:

U.S. standard sieve size	Percent by weight passing
1 inch	100
¾ inch	85-100
No. 4	45-95
No. 200	0-8

2. The granular base shall hav a plasticity index of no greater than 3 when tested in accordance with ASTM D4318
3. The coarse aggregate should have a percent of wear, when subjected to the Los Angeles Abrasion Test (ASTM C131), of no greater than 50.

E. Type E:
1. Type E material shall be crushed rock commonly known as drain rock and shall conform to the following gradation:

U.S. standard sieve size	Percent by weight passing
1-1/2 inch	100
3/4 inch	30-75
1/2 inch	15-55
1/4 inch	0-5

2. Type E material shall be composed of hard, durable, sound pieces having a specific gravity of not less than 2.65

F. Type F:

1. Type F material shall be crushed rock and shall conform to the following gradation:

U.S. standard sieve size	Percent by weight passing
1-1/2 inch	87-100
3/4 inch	45-90
No. 4	20-50
No. 30	6-29
No. 200	0-12

2. Type F material shall be composed of hard, durable, sound pieces having a specific gravity of not less than 2.65.

G. Type G:

1. Type G material shall be a granular sand material free from clay balls, organic matter, and other deleterious substances. Sand shall have a sand equivalent of 30 per ASTM D 2419 and conform to the following gradation

U.S. standard sieve size	Percent by weight passing
3/8 inch	100
No. 4	75-100
No. 30	12-50
No. 100	5-20
No. 200	0-10

2. Test sand to see that it is not salty or corrosive to steel as follows:
   a. Electrical Resistivity shall be greater than 10,000 ohm-cm (per ASTM G-57, soil box method)
   b. pH shall be greater than 7 (per ASTM G-52)
   c. Chloride shall be less than 50 mg/kg of soil (EPA Test Method 325)
   d. Sulfate shall be less than 100 mg/kg of soil (EPA Test Method 375)

H. Type H:

1. Type H material shall be 6-inch riprap. Riprap shall be graded rock having a range of individual rock weights as follows:

Weight of stone	Percent smaller by weight
10 pounds	100
5 pounds	80-100
2 pounds	45-80
1 pound	15-45
1/2 pound	5-15
Below 1/2 pound	0-5

2. Specific gravity shall be between 2.5 and 2.82.

I. Type I:

1. Type I material shall be 12-inch riprap. Riprap shall be graded rock having a range of individual rock weights as follows:

Weight of stone	Percent smaller by weight
160 pounds	100
100 pounds	80-100
50 pounds	45-80
20 pounds	15-45
5 pounds	5-15
1 pound	0-5

2. Specific gravity shall be between 2.5 and 2.82.

J. Type J:

1. Type J material shall be unclassified material and may be obtained from excavation on site. The material may contain extraneous material such as demolition waste, unsuitable material excavated from beneath structures, and clearing and grubbing debris up to 50 percent by volume. Extraneous material shall be thoroughly mixed and the maximum size of organic particles shall be 6 inches.

K. Water for Compaction:

1. Water shall be free of organic materials, a pH of 7.0 to 9.0, a max chloride concentration of 200 mg/L, and a max sulfate concentration of 500 mg/L. Provide all work needed to transport water for earthwork including piping, valves, pumps, and trucks to convey water to the point of use.

PART 3 EXECUTION

3.01 GENERAL

A. Excavate and dispose of all materials of whatever nature encountered, including all obstructions that would interfere with the proper execution and completion of the Work. The removal of these materials shall conform to the lines and grades indicated or ordered.

3.02 PROTECTION:

1. Protect existing surface and subsurface features on-site and adjacent to site. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing items indicated to remain in place.
2. Protect existing utilities from damage or disturbance. Immediately notify utility whose facilities have been damage or disturbed. At the utility owner's option, repair damaged utilities or compensate utility owner for completing the repairs.

3.03 SITE EXCAVATION AND GRADING

A. Remove rock, soil, organics, pavement, hard pan, loose shale, loose stone, and other obstructions as directed by Construction Manager.

B. Preparation of Ground Surface for Embankments or Fills:
   1. Before fill is started, scarify to a minimum depth of 8 inches in all proposed embankment and fill areas.
   2. Where ground surface is steeper than one vertical to four horizontal, plow surface in a manner to bench and break up surface so that fill material will bind with existing surface.

C. Finish Grading:
   1. Finished surfaces shall be:
      a. Smooth, compacted and free from irregularities.
      b. To the specified grade plus or minus 0.10 foot except where a local change in elevation is required to match sidewalks, curbs, manholes and catch basins, or to ensure proper drainage. Allowance for topsoil and grass cover, and subbase and pavement thickness shall be made so that the specified thickness of topsoil can be applied to attain the finished grade.
      c. When the work is an intermediate stage of completion, the lines and grades shall be as specified plus or minus 0.5 foot to provide adequate drainage.
      d. Replace topsoil in top 12 inches of unpaved excavated or disturbed areas. Rocks larger than 2-1/2 inches in maximum dimension, roots and other debris on the surface of the slope shall be removed and disposed of prior to placement for topsoil.

D. Protection of Finish Grade:
   1. During construction, shape and drain embankment and excavations.
   2. Maintain ditches and drains to provide drainage at all times.
   3. Protect graded areas against action of elements prior to acceptance of work.
   4. Reestablish grade where settlement or erosion occurs.

E. Embankments and Fills:
   1. Construct embankments and fills at locations and to grade indicated.
   2. Compact by sheepsfoot, pneumatic rollers, vibrators, or by other equipment as required to obtain specified density.
   3. Control moisture for each layer necessary to meet requirements of compaction.

F. Over Excavation:
   1. Where the undisturbed condition of natural soils is inadequate for support of the planned construction, the Construction Manager will direct the Contractor to overexcavate to adequate supporting soils. The excavated space shall be filled to the specified elevation with backfill. The overexcavated space under footings may be filled with concrete. The quantity and placement of such material will be paid for as extra work.

G. Surplus Material:
   1. Unless otherwise specified, surplus excavated material shall be disposed of off site in accordance with applicable ordinances and environmental requirements.

2. If the quantity of surplus material is specified, the quantity specified is approximate. The Contractor shall satisfy himself that there is sufficient material available for the completion of the embankments before disposing of any material inside or outside the site. Shortage of material, caused by premature disposal of any material by the Contractor, shall be replaced by the Contractor.
3. Material shall not be stockpiled to a depth greater than 5 feet above finished grade within 25 feet of any excavation or structure except for those areas designated to be preconsolidated. For these areas, the depth of stockpiled material shall be as specified. The Contractor shall maintain stability of the soil adjacent to any excavation.

H. Borrow Material:
1. If the quantity of acceptable material from excavation is not sufficient to construct the embankments required by the work, the quantity of material needed to complete the embankments shall consist of imported borrow conforming to specified requirements.

I. Hauling:
1. When hauling is done over highways or city streets, the loads shall be trimmed and the vehicle shelf areas shall be cleaned after each loading. The loads shall be watered after trimming to eliminate dust.

J. Haul Roads:
1. The Contractor shall construct haul roads required to transport materials on site. Alignment of haul roads shall be selected to avoid interference with plant operations. Haul roads shall be removed after completion of embankment construction.

K. Control Of Erosion:
1. The Contractor shall maintain earthwork surfaces true and smooth and protected from erosion. Where erosion occurs, the Contractor shall provide fill or shall excavate as necessary to return earthwork surfaces to the grade and finish specified.

3.04 CLASSIFICATION OF FILL

A. Fill material shall be placed in horizontal layers and compacted with power-operated tampers, rollers, idlers, or vibratory equipment. Material type, maximum layer (lift) depth, relative compaction, and general application are specified in Table A. Unless otherwise specified, fill classes shall be used where specified in Table A under general application.

Table A, Fill Classifications

Fill class	Material type	Maximum uncompressed layer depth, inches	Minimum relative compaction, percent	General application
A1	A	8	95	Bedding for pipe, initial pipeline backfill
B1	B	8	95	Structure backfill against walls.
C1	C	8	90	Trench backfill for pipe outside of paved or gravel road areas, or not required to support structural loads or vehicle traffic.
D1	D	-	95	Granular base for floor slabs. Structural fill under foundations, Top Layer of road base for gravel road section.

Table A, Fill Classifications

Fill class	Material type	Maximum uncompressed layer depth, inches	Minimum relative compaction, percent	General application
E1[a]	E	8	-	Fill under slabs for structures and tank slabs
F1[b]	F	8	95	Lower 6" of road base for gravel road section.
G1	G	8	95	Bedding, initial, and subsequent pipeline backfill for small diameter (<=2) plastic pipe and direct buried electrical conduits.
H1[c]	H	-	-	Trench or excavation bottom soil stabilization
I1	I	-	-	Embankment slope face, channel slope face
J1	J	-	-	Mounded backfill over trench in non-road areas.

a. Compaction of layers shall be accomplished in two passes of equipment with complete coverage across the width of the field.

b. Material shall not be used for bedding or initial backfill for plastic pipe.

c. Riprap to be pressed into unstable trench bottom soil until trench bottom will support placement and compaction requirements for backfill.

3.05 EARTHWORK FOR STRUCTURES

A. Structure Excavation:

1. The bottom shall not be more than 0.15 foot above or below the lines and grades specified. If the elevation of structure excavation is not specified, the excavation shall be not more than 0.15 foot above or below the elevation specified for fill material below the structure. Slopes shall vary no more than 0.5 foot from specified grade unless the excavation is in rock where the maximum variation shall be 2 feet.
2. Should the excavation be carried below the lines and grades specified on the drawings or should the bottom of the excavation be disturbed because of the Contractor's operations and require over-excavation and backfill, the Contractor shall refill such excavated space to the proper elevation in accordance with the procedure specified for backfill. The cost of such work shall be borne by the Contractor.
3. Unless otherwise specified, excavations shall extend a sufficient distance from walls and footings to allow for placing and removal of forms, installation of services, and for inspection, except where concrete is specified to be placed directly against excavated surfaces.

B. Foundation Treatment:

1. Rock foundations for concrete or masonry footings shall be excavated to sound material. The rock shall be roughly leveled or cut to steps and shall be roughened. Seams in the rock shall be grouted under pressure as directed by the Construction Manager and paid for as extra work.
2. Site preparation shall consist of over-excavating the native soils. Areas for slab foundations shall be over-excavated to provide for a minimum of 1.0 foot of structural fill. Soils at the base of excavation shall be scarified to a depth of 8 inches, or exposure of bedrock. The moisture content of the scarified soil shall be adjusted to 0.0 to +2.0 percent of the modified, optimum moisture content (OMC) and compacted to a minimum of 95 percent of the modified, maximum dry density (ASTM D1557)..

3. Whenever any structure excavation is substantially completed to grade, the Contractor shall notify the Construction Manager who will make an inspection of the foundation. No concrete or masonry shall be placed until the foundation has been inspected by the Construction Manager. The Contractor shall, if directed by the Construction Manager, dig test pits and make test borings and foundation bearing tests. If the material tested is undisturbed soil, the cost thereof will be paid for as extra work. If the material tested is backfill material, the cost thereof will be paid as specified in the General Conditions of the Contract Documents.

C. Structure Backfill:
   1. Unless otherwise specified, structural backfill shall be Class B1.
   2. After completion of construction below the elevation of the final grade, and prior to backfilling, forms shall be removed and the excavation shall be cleaned of debris.
   3. Structure backfill shall not be placed until the subgrade portions of the structure have been inspected by the Construction Manager. No backfill material shall be deposited against concrete structures until the concrete has developed a strength of not less than 75 percent of the minimum 28-day compressive strength.
   4. Place structural backfill material around structures, channels, vaults, manholes, and other structures to the lines and grades shown or specified. If hand compaction equipment is used, limit loose lift depths to 6-inches or less.
   5. Compact each lift as hereinafter specified. Stop structural backfill at least 6 inches below finished grade in areas where topsoil is to be replaced.
   6. Do not operate earthmoving equipment within 5 feet of any concrete structure. Structural backfill shall not be placed until the concrete has developed to at least 75 percent of the minimum 28-day compressive strength, and in all cases not less than 24 hours after the last pour.
   7. Place and compact fill or backfill adjacent to concrete structures using hand-operated tampers, roller wheels, or other equipment that shall not damage structure.
   8. Backfill material shall be placed in uniform layers and shall be brought up uniformly on all sides of the structure.
   9. Compaction of structure backfill shall not be done by water ponding and jetting.
   10. Structural fill soil shall be spread in loose layers, moisture conditioned, and constructed in lifts no greater than eight-inches compacted thickness. Moisture content at the time of compaction shall be within ± 2 percent of modified, optimum moisture content (ASTM D1557). Structural fill shall be compacted a minimum density of 95 percent of modified, maximum dry density.
   11. Unless otherwise specified, backfill around and above pipelines within the excavation line of any structure shall be the same as that specified for structures.

3.06 EARTHWORK FOR PIPELINES AND CONDUITS

A. Earthwork for Pipelines and Conduits shall be performed in accordance with Section 31 21 33 Trenching, Backfilling, and Compacting for Utilities.

B. Pipe Trench Materials:
   1. Trench Foundation:
      a. Fill Class H1 unless otherwise specified.
   2. Pipe Bedding and Pipe Zone:

a. Provide concrete encasement for all piping and conduits located below structures as indicated in the Drawings.
b. General Piping: Fill Class A1 or A2 unless otherwise specified.
c. Plastic piping less than 2-inches in diameter and direct buried electrical or control conduits: Fill Class G1 unless otherwise specified.

3. Trench Zone:
   a. Beneath AC paved roads and road shoulders: Fill Class F1 unless otherwise specified.
   b. Other Locations: Native material excavated from the project trenches which is free from organic matter, nested cobbles 3-inches or larger, or other deleterious matter and meeting the requirements for earth fill as specified.
      1) If Contractor cannot achieve the required trench zone compaction with the native material excavated from the project trenches, then Contractor shall use an imported material, or another material acceptable to the Construction Manager.
4. Final Backfill:
   a. Beneath AC paved roads and road shoulders: Fill Class F1 unless otherwise specified.
   b. Other Locations: Six (6) inches of topsoil

C. Trench Zone Cross Drain:
   1. All locations: Fill Class E1 unless otherwise specified.
   2. Specified trench zone drain interval length may be adjusted to best meeting existing native soil conditions. Locate drains at locations where pervious native materials were found during trenching activities. Provide enough cross drains so that the average spacing between drains is 100 ft.

3.07 EARTHWORK FOR EMBANKMENTS

A. Foundation Preparation:
   1. The surface of the foundation shall not contain standing water and shall be free of loose material, foreign objects and rocks greater than 3 inches in maximum dimension. Immediately prior to placement of embankment fill material, the foundation surface shall be thoroughly moistened, scarified to a depth of 6 inches, moisture conditioned again as necessary and recompacted to 95 percent relative compaction. After the preparation has been completed, the Contractor shall promptly place and compact the first lift of embankment on the foundation to prevent damage to the surface. If the foundation surface is damaged, the Contractor shall repair the surface to the specified condition. In any areas where materials become soft or yielding, such materials shall be removed, disposed of, and replaced with specified material. The surface of the embankment shall be maintained to permit travel of construction equipment. Ruts in the surface of any layer shall be filled and leveled before compacting.

B. Embankment Fill:
   1. Rocks, broken concrete, or other solid materials, which are larger than 3 inches in greatest dimension, shall not be placed in embankment areas where piles are to be placed or driven.

2. Fill material having a sand equivalent value less than 10 shall be placed in the lower portions of embankments and shall not be placed within 2.5 feet of finished grade.
3. When the embankment material consists of large, rocky material, or hard lumps, such as hardpan or cemented gravel which cannot be broken readily, such material shall be well distributed throughout the embankment. Sufficient earth or other fine material shall be placed around the larger material as it is deposited so as to fill the interstices and produce a dense, compact embankment.
4. Unless otherwise specified, the embankment shall be raised to form an approximately horizontal plane extending transversely to the final slopes. The embankment shall be crowned at all times during construction so that water will drain readily off the embankment.
5. The temporary differential elevation between any two adjoining zones of the embankment due to construction operations shall not exceed 24 inches.
6. If the compacted surface of any layer of material is too smooth to bond properly with the succeeding layer, the surface shall be scarified. If required, the surface shall be sprinkled or otherwise moisture conditioned before the succeeding lift is placed. Any surface crust formed on a layer of fill material that has been dumped and spread shall be broken up by harrowing and, if required, the full depth of the affected layer shall be moisture conditioned immediately prior to rolling.

C. Key Construction: NOT USED

D. Embankment Tolerances:
1. General: Embankment slopes within 4 feet of shoulder grade shall vary less than 0.5 foot from the designated slope. Slopes beyond 4 feet from shoulder grade shall vary less than 1 foot from the designated slope. Measurements for variance shall be made perpendicular to the slope. Slopes which are 6 to 1 or flatter shall vary less than 0.2 foot from the designated slope.
    a. If embankments are constructed of rock greater than 12 inches in diameter, the slopes more than 4 feet below shoulder grade may vary up to 2 feet from the designated slope.
2. Roadway Embankment Tolerances: The excavated surface shall be less than 0.08 foot above or below the grades specified after deducting for the roadway pavement thickness.
    a. Vertical alignment tolerances permitted on the roadway surface shall not exceed plus or minus 0.30 feet from the vertical alignment specified, with the provision that within the tolerance range local surface irregularities shall not exceed 0.15 feet as measured by the gap between the roadway surface and a 10-foot straightedge placed on any flat graded surface. On vertical curves, the same standards will apply except that an additional gap allowance will be made for the road surface curvature over the 10-foot length of the straightedge.
    b. Horizontal alignment tolerances permitted shall not exceed plus or minus 1 foot providing the departure is relatively uniform over any specific length of the roadway.
    c. Roadway median strips shall be graded to drain and shall not vary more than 0.1 foot from the specified grade.

E. Surcharge Embankment:

1. Where specified in Section 00 73 00, the surcharge embankment shall remain in place for the required settlement period before excavation for footings or construction of foundation piles.
2. Surcharge embankments shall not encroach upon traveled ways nor upon existing improvements that are subject to damage. The Contractor shall restrain the embankment material.

3.08 PLACING AND COMPACTING FILL

A. Remove form materials and trash from excavation before placing fill material. Remove uncompacted fill, loose and disturbed soils until firm soils or formational material are exposed. Removed materials may be used as compacted fill if they meet specifications.

B. Under earth fills, scarify the exposed surface to a depth of 8 inches, moisture condition to within 2 percent of optimum moisture content, and compact to at least 95 percent relative compaction.

C. Obtain Construction Manager inspection and authorization to begin backfill on the exposed surface before starting placement of fill.

D. Add water to the backfill material or dry the material, as necessary, to obtain a moisture content within 2 percent of optimum. Obtain a uniform moisture content throughout the material of each layer being compacted.

E. If the backfill material is saturated from groundwater, rains or any other source, remove and replace the unsatisfactory material with suitable material compacted to the specified density. No additional payment will be made for removal and replacement of unsatisfactory material.

F. Where earth fills are to be constructed on slopes steeper than 5:1, excavate an equipment width keyway beneath the toe at the base of the fill. The keyway will have a minimum width of 10 feet and slope at least 2 percent into the slope. Continue benching into competent material as the fill progresses up slope. All benching shall be inspected and authorized by the Construction Manager before fill placement begins.

G. Place all fills in 6- to 8-inch lifts, brought to within 2 percent of optimum moisture content, and compacted to 90 percent relative compaction (except as specified under “Trench Backfill and Compaction”. Do not place rocks larger than 3 inches in maximum dimension in the fills.

H. Provide special attention to compaction along the top and outer edge of the earth fill slopes during construction. Backroll fill slopes after each fill lift is completed. Perform additional rolling and trimming as may be required at the finish of the slope construction to correct local surficial slumping

3.09 SUBGRADE FOR PAVEMENT

A. The prepared subgrade shall be scarified to a depth of at least 12 inches and recompacted to at least 95 percent of the maximum density.

B. Class F1 unless otherwise specified.

3.10 SITE FILL

A. Unless otherwise specified, site fill shall be Class B1 fill. If the existing slope in an area to be filled is greater than 5:1, the Contractor shall bench the area prior to filling.

3.11 GROUTING RIPRAP – NOT USED

3.12 SUPPORT OF EXCAVATIONS

A. As required by Section 33 05 25, Excavation Support Systems.

3.13 CLSM TRENCH CUTOFFS (I.E. TRENCH PLUGS) – NOT USED

3.14 COLD WEATHER LIMITATIONS IN PLACING FILL AND BACKFILL

A. Unless allowed in the authorized Cold Weather Construction Plan, earth fills and backfills requiring 95 percent or higher relative compaction shall not be placed when either atmospheric temperature, or the temperature of the existing ground or the fill being placed, are below 35 degrees Fahrenheit unless both the existing ground and the fill being placed are both non-frost susceptible materials.

B. Earth fills and backfills requiring 90 percent or lower relative compaction may be placed when temperatures are below 35 degrees Fahrenheit if the required compaction is achieved. If the required compaction is not achieved, the work shall be removed and re-compacted.

C. Do not place any fill or backfill materials which require 95 percent, or higher, relative compaction if the excavation or subgrade contains frozen moisture (snow, ice, sleet, etc.), frozen earthen materials, or earthen materials which have been deposited in the excavation due to freezing, thawing, precipitation, or other inappropriate means.

D. Do not place fill materials which contain frozen moisture (snow, ice, sleet, etc.) except as allowed in the paragraphs above.

E. Work performed outside the required temperature limitations is subject to rejection, removal and replacement.

3.15 TOPSOIL STOCKPILING AND PLACEMENT

A. Provide 6 inches of top soil in all regraded areas scheduled for revegetation in the drawings and Section 02 90 00.

3.16 STOCKPILE LIMITATIONS AND DISPOSAL OF EXCAVATED MATERIAL

A. Protect installed pipelines after installation from differential settlement of ground by doing the following:
   1. After backfilling pipelines, do not ever (temporarily or permanently) allow more than 2.5-feet of stockpile or fill depth to be placed (above existing grades shown in drawings) in any part of the permanent easement or within 15-feet (horizontally) from centerline of pipe.

2. After backfilling pipelines, do not allow stockpiles of earth materials, fills (or other materials of similar density and size) to be deeper (or higher) than a 6:1 (6 horizontal to 1 vertical) upward sloping plane originating at existing ground atop pipe centerline and extending upward and outward from pipe in each direction. For instance, at 18-feet away from pipe centerline, neither temporary, nor permanent, fill depth shall exceed 3 feet (above existing grade) except where the contract document specifically require fills.
3. If temporary fill is placed in the easement, manholes shall not be buried and shall remain accessible at all times. Temporary fills shall be graded to direct drainage away from manholes.

B. Prevent dust from damaging homes, businesses, public and private facilities, crops, cultivated fields, and other improvements, or causing a nuisance to persons. Perform dust control for the duration of the project.

C. Legally dispose of all excavated materials unsuitable for backfill, and other unused excavated materials. Excavated materials suitable for backfill may temporarily be stored at the site so-as not to interfere with public traffic or concurrent work or to mix with other stockpiled material.

D. Notify the Construction Manager immediately if contaminated soils are found on the project.

E. Provide adequate facilities for drainage of water from stockpiled excavated material and adequate facilities for handling of storm drainage from storage and other area.

3.17 CLSM PLACEMENT AND SLIDE RAIL SHORING REMOVAL – NOT USED

3.18 EARTHBIND – NOT USED

3.19 FIELD QUALITY ASSURANCE

A. Quality Assurance Testing to be completed by Contractor in accordance with Section 01 45 23, Testing and Inspection Services.

B. Costs of all originally scheduled field quality assurance tests and inspections resulting in passing conditions shall be paid by Contractor. Should any originally scheduled test or inspection fail to meet requirements of the Contract Documents, the Contractor shall be responsible for the costs of retesting or re-inspection of Work including inspector's and tester's time and trips.

C. Provide Construction Manager and inspectors with immediate access for testing and observation of soils-related work.

D. Ensure excavations are safe for workers, Owner, Construction Manager, testing agency personnel, and inspectors.

E. Should any test or inspection fail to meet requirements, perform corrective work necessary to bring the Work into compliance with the requirements of the Contract Documents.

F. Frequency of Compaction Testing:

1. See Section 31 21 33, Trenching, Backfilling, and Compacting for Utilities for frequency of compaction testing in pipe trenches.

G. Frequency of Source Gradation Confirmation Testing:
   1. One test per each 1,000 cubic yards of imported backfill material placed, or at frequency as modified by Construction Manager where backfill material appears, by visual inspection, to be deviating from specification requirements.

END OF SECTION

SECTION 31 26 20

FILTER FABRIC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Nonwoven filter fabric.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D 4491 - Standard Test Method for Water Permeability of Geotextiles by Permittivity.
   2. D 4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   3. D 5261 - Standard Test Method for Measuring Mass per Unit Area of Geotextiles.

1.03 DEFINITIONS

A. Filter fabric: Nonwoven geotextile fabric manufactured from polypropylene fibers.

1.04 SUBMITTALS

A. Product data.

B. Samples.

C. Quality control submittals:
   1. Certificates of Compliance.
   2. Manufacturer's Instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage and protection:
   1. Furnish filter fabric in protective covers capable of protecting the fabric from ultraviolet rays, abrasion, and water.

1.06 PROJECT CONDITIONS

A. Take field measurements to determine the lengths and dimensions of the surfaces to receive the fabric.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Ten Cate Nicolon, Charlotte, NC, Mirafi 1120N – for landscaping applications under landscaping rock or rip rap

2. Ten Cate Nicolon, Charlotte, NC, Mirafi 140N – for drainage applications around perforated pipe

2.02 MATERIAL REQUIREMENTS

A. Physical properties: Meet the following minimum requirements (1120N):

Property (1)	Test Method	Requirements(1)
Grab tensile strength	ASTM D 4632	300 pounds
Grab tensile elongation	ASTM D 4632	50 percent
Minimum Permittivity	ASTM D 4491	0.8 per second

*(1) Minimum average roll values.

B. Physical properties: Meet the following minimum requirements (140N):

Property (1)	Test Method	Requirements(1)
Grab tensile strength	ASTM D 4632	1200 pounds
Grab tensile elongation	ASTM D 4632	50 percent
Minimum Permittivity	ASTM D 4491	2.0 per second

*(1) Minimum average roll values.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Verify that conditions are satisfactory for the installation of filter fabric.

3.02 PREPARATION

A. Surface preparation:

1. During grading operations, take care not to disturb the subgrade.
2. This may require use of lightweight dozers for low strength soils such as saturated, cohesionless, or low cohesion soils.

B. Prior to placement of fabric: Prepare surface to smooth condition free of debris, depressions, or obstructions that may damage the fabric.

3.03 INSTALLATION

A. Follow manufacturer's installation instructions and as complimented herein.

B. Place the filter fabric smoothly without folds or wrinkles.

C. Use special care when placing the filter in contact with the soil so that no void spaces occur between the filter and the prepared surface.

D. Overlap the parallel rolls and ends of rolls a minimum of 24 inches and not less than manufacturer's instructions.

E. Do not drag filter fabric across subgrade.

F. Make overlaps at ends of rolls in the direction of the aggregate placement with the previous roll on top.

G. Use lightweight dozers if necessary. Do not allow equipment directly on filter fabric.

H. Do not leave fabric uncovered for more than 5 days.

I. Use 18 inch long piins to secure the fabric during installation.

3.04 FIELD QUALITY CONTROL

A. Inspection:
   1. Before covering, the condition of the fabric will be observed by the CONSTRUCTION MANAGER to determine that no holes or rips exist in the fabric.
   2. Repair all holes and rips by placing a new layer of fabric extending beyond the defect in all directions a distance equal to the minimum overlap required for adjacent rolls.

END OF SECTION

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SECTION 31 35 26.17

60-MIL TEXTURED HDPE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Furnish and install a 60 mil, high-density polyethylene (HDPE) geomembrane liner (textured on both sides). Geomembrane shall be black.

1.02 RELATED SECTIONS

A. Section 31 10 00 – Site Clearing

B. Section 31 23 00 – Excavation and Fill

C. Section 31 26 20 – Filter Fabric

1.03 REFERENCES

A. Latest Version of American Society for Testing and Materials (ASTM) Standards:

B. Latest Version of the Geosynthetic Research Institute (GRI) Standards:

1.04 DEFINITIONS

A. Batch: A quantity of resin, usually the capacity of one railcar, used in the fabrication of the geomembrane sheet. The finished sheet will be identified by a roll number corresponding to the particular quantity of resin used.

B. Bridging: The condition when geomembrane becomes suspended over its subgrade due to contraction of the material or poor installation.

C. Construction Quality Control (QC) Personnel: The party, secured by the Contractor who is responsible for all of the Contractor's Construction Quality Control activities related to installation of the geosynthetic components of the lining system.

D. Construction Quality Assurance (QA) Personnel: The site representative of the Owner responsible for site Quality Assurance documentation.

E. Extrudate: The molten polymer that is emitted from an extruder during seaming using either extrusion fillet or extrusion flat methods. The polymer is initially in the form of a ribbon rod, bead or pellets.

F. Fabricator: The party responsible for the fabrication of geomembrane panels constructed from rolls received from the manufacturer.

G. Geomembrane: An essentially impermeable membrane used as a solid or liquid barrier. In the context of this project it implies a 60mil high density polyethylene (HDPE) product with texture on both sides or equivalent.

H. Geomembrane Manufacturer: The party responsible for the production of the geomembrane rolls from resin and for the quality of the resin.

I. Geomembrane: An essentially impermeable membrane used as a solid or liquid barrier. Synonymous term for geomembrane.

J. Subgrade: The soil or upon which the geomembrane lies.

K. Geonet Composite: A geonet/geotextile geocomposite used for drainage. In this case it means a composite material made up of a lattice type HDPE material and a geotextile fabric heat laminated to both sides.

L. Installer: The party responsible for field handling, transporting, storing, deploying, seaming, temporary restraining (against wind), and installation of the geomembrane.

M. Panel: The unit area of geomembrane that will be seamed in the field. If the geomembrane is not fabricated into panels in a factory, a panel is identified as a roll or portion of a roll without any seams.

1.05 SUBMITTALS

A. The following information shall be provided:
   1. Product Data: Submit the following to Engineer for written approval (Engineer shall forward approval to both QA and QC personnel) prior to ordering:
      a. Resin Data.
         1) Statement of production date or dates.
         2) Product Certifications.
         3) Copy of quality control certificates issued by manufacturer.
         4) Test reports from manufacturer.
      b. Geomembrane Roll Data.
         1) Statement of production date or dates.
         2) Laboratory test results and certification stating that the geomembrane meets the product requirements (see Part 2 Products).
         3) Certification stating that all geomembrane rolls are furnished by one supplier, and that all rolls are manufactured from one resin type obtained from one resin supplier.
         4) Copy of quality control certificates issued by manufacturer.
         5) Test reports from the manufacturer.
         6) Typical results of complete notched constant tensile load test (GRI-GM-5) for specified resin and sheet thickness.
         7) Statement certifying that no reclaimed polymer is added to the resin.
         8) Statement listing percentages/total of processing aids, antioxidants, and other additives other than carbon black added to or in the resin.
         9) Geomembrane delivery, storage, and handling instructions.
         10) Geomembrane installation instructions.
         11) Sample warranties for review.

c. Extrudate Beads and/or Rod.
    1) Statement of production date or dates.
    2) Laboratory certification stating that the extrudate meets the product requirements (see Part 2 - Products).
    3) Certification stating that all extrudate is manufactured by one manufacturer and resin is supplied from one supplier.
    4) Copy of quality control certificates issued by manufacturer.
    5) Test reports from the manufacturer.
    6) Certification stating that the extrudate bead or rod resin is the same type, from the same manufacturer and compatible with the resin used to manufacture the geomembrane supplied for this project.

2. Schedules and Drawings (Installer)
    a. Submit installation schedule to Owner and Engineer. Include hours worked per day, week and per shift.
    b. Installation layout drawings: Four weeks prior to installation of geomembrane, submit drawings to Engineer showing the panel layout indicating both fabricated (if applicable) and field seams, and details not conforming to the Drawings. Upon Engineer review, use these drawings for installation of geomembrane.
3. Qualifications (Installer).
    a. Submit two weeks prior to installation, name of installer, and resume of installation supervisor/field engineer to be assigned to the project. Engineer shall review and approve installers and forward approval to both the QA and QC personnel.
    b. Submit, two weeks prior to installation, resume of master seamer.
    c. Submit, two weeks prior to installation, resumes of installation seamers performing seaming operations.
4. Field Quality Control Documents (Installer). Follow project Construction QA/QC Plan.
5. Submit upon completion of the installation: (Installer).
    a. Certificate stating the liner has been installed in accordance with the Drawings and Specifications.
    b. The warranty obtained from the manufacturer/fabricator and the installation warranty.
    c. As-built drawings showing location of panels, seams, repairs, patches, and destructive samples, including measurements.
    d. Copies of seam test results.

1.06 QUALIFICATIONS

A. Manufacturer/Fabricator/Installation Qualifications: The following are pre-qualified. Substitutions may be considered.
    1. GSE Lining Technology, Inc.
    2. Agru
    3. Polyflex

B. Installer: Must have successfully installed a minimum of 10,000,000 square feet of welded polyethylene geomembrane with documented references.

C. Master Welder Qualifications: Must have completed a minimum of 5,000,000 square feet of polyethylene geomembrane seaming work using the type of seaming apparatus proposed for use on this project.

D. Other Seamers Qualifications: Must have seamed a minimum of 1,000,000 square feet of HDPE geomembrane.

1.07 LABELING, DELIVERY, STORAGE, AND HANDLING (MANUFACTURER)

A. Labeling.
   1. Each roll of geomembrane delivered to the site shall be labeled by the manufacturer. The label shall clearly state the manufacturer's name, product identification, thickness, length, width and roll number.
   2. The label shall be found on either of the end caps, an inside edge of the core, and outside the core.

B. Delivery.
   1. Deliver materials to the site only after Engineer accepts required submittals.
   2. Separate damaged rolls from undamaged rolls and store at locations designated by QA Inspector until QA Officer determines proper disposition of the material.
   3. QA Officer will determine damage.
   4. Deliver in rolls, do not fold.

C. Storage on Site: (Installer).
   1. Store geomembrane rolls in the space allocated by Owner.
   2. Store geomembrane rolls to protect from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat or other damage.
   3. Store geomembrane rolls on contractor prepared surface (not on wooden pallets).
   4. Stack geomembrane no more than four rolls high.

D. Handling on Site: (Installer).
   1. Use appropriate handling equipment to load, move, or deploy geomembrane rolls. Appropriate handling equipment includes cloth chokers and spreader bar for loading, spreader, and roll bars for deployment. Dragging panels on ground surface will not be permitted.
   2. Do not fold geomembrane material; folded material will be rejected.
   3. Contractor is responsible for off-loading, storage, and transporting material from storage area to installation site.

1.08 QUALITY CONTROL

A. The Contractor will engage and pay for the services of a party responsible for the continuous testing and documentation of the geomembrane material being installed. Testing will be performed in accordance with both the Construction QA/QC Plan and these Specifications.

1.09 QUALITY ASSURANCE

A. Owner will engage and pay for the services of independent Construction Quality Assurance (QA) Personnel.

1.10 WARRANTY

A. Provide manufacturer's warranty for geomembrane material in compliance with provisions of the Conditions of the Contract. Provide a minimum 20-year pro rata warranty for the material against deterioration due to exposure to the elements, either exposed or buried. The warranty for material must cover costs of material replacement and installation; assuming the area is rendered in a clean, dry unencumbered condition. In the event the area cannot be rendered as such, compensation for defective material will be provided to Owner on a pro rata basis for the estimated cost to Owner at that time of supplying and installing material to a clean, dry, and unencumbered condition by a third party installer.

B. Installation: Provide an installation warranty for geomembrane material in compliance with the conditions of the Contract. Provide a minimum of 2-year non-pro rata warranty for the installation against defects.

PART 2 PRODUCTS

2.01 GEOMEMBRANE RESIN

A. Meet the following requirements unless otherwise approved:

Test	Test Designation	Requirements
Density (g/cm)[1]	ASTM D-792 Method A or ASTM D-1505	0.94 minimum

[1] Measure on pure resin without additives.

2.02 GEOMEMBRANE

A. Manufacturing.
   1. Do not exceed a combined maximum total of 1 percent by weight of additives other than carbon black or pigment. Identify percentage of processing aids, antioxidants, and other additives other than carbon black.
   2. Do not exceed 3.5 percent by weight of finished geomembrane for total combined processing aids, antioxidants, carbon and other additives. Do not exceed 3% carbon black by weight.
   3. All additives for UV protection, thermal stability, color, or processing agents must not "bloom" to the surface over time or inhibit welding.
   4. Provide finished product free from blemishes, holes, pin holes, bubbles, blisters, excessive gels, undispersed resins, and/or carbon black, contamination by foreign matter and nicks or cuts on edges.
   5. Roll manufactured sheets or panel for shipment.
   6. Geomembrane may consist of standard black or meeting the following requirements unless otherwise approved:

Test	Test Designation	Test Value	Testing Frequency (min.)
Sheet Thickness (min. ave.) • lowest individual for 8/10 values • lowest individual for any of the 10 values	ASTM D 5994	60 mil (-5%) -10% -15%	Per roll
Asperity Height mils (min ave.) *(1)*	ASTM D 7466	10 mil	Every 2nd roll *(2)*
Tensile Properties *(3)* (min. ave.)	ASTM D 6693 Type IV		20,000 lb
• yield strength		126 lb/in	
• break strength		90 lb/in	
• yield elongation		12%	
• break elongation		100%	
• Tear Resistance	ASTM D 1004	42 lb	45,000 lb
Puncture Resistance	ASTM D 4833	90 lb	45,000 lb
Stress Crack Resistance *(4)*	ASTM D 5397 (Appendix)	300 hr.	Per GRI GM10
Carbon Black Content (range)	ASTM D 4218 *(3)*	2.0-3.0 %	20,000 lb
Carbon Black Dispersion	ASTM D 5596	*note (6)*.	45,000 lb
Oxidative Induction Time (OIT) (min ave.) *(5)*			200,000 lb
(a) standard OIT	ASTM D 3895	100 min.	
-or-			
(b) High Pressure OIT	ASTM D 5855	400 min	
Oven Aging at 85°C *(7) (8)*	ASTM D 5721		Per each Formulation
(a) standard OIT- (min ave.) %ret after 90 days	ASTM D 3895	55%	
-or-			
(b) High Pressure OIT- (min ave.) %ret after 90 days	ASTM D 5855	80%	
UV Resistance (9)	GRI GM 11		Per each formulation
(a) standard OIT- (min ave.)	ASTM D 3895	NR *(10)*	
-or-			
(b) High Pressure OIT- (min ave.) %ret after 1600 hrs *(11)*	ASTM D 5855	50%	

1. *of 10 readings; 8 out of 10 must me ≥7 mils, and lowest individual reading must be ≥ 5 mils; also see note 6.*
2. *Alternate the measurement side for double sided textured sheet*
3. *Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.*
   Yield elongation is calculated using a gage length of 1.3 inches
   Break elongation is calculated using a gage length of 2.0 inches
4. *P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.*
5. *Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.*
6. *Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3*
7. *The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.*
8. *It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.*
9. *The condition of the test should be 20 hr UV cycle at 75°C followed by 4 hr. condensation at 60°C.*
10. *Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.*
11. *UV resistance is based on percent retained value regardless of the original HP-OIT value*

2.03 EXTRUDATE ROD OR BEAD

A. Extrudate rod or bead must:
   1. Meet the geomembrane manufacturer requirements.
   2. Be made from same resin as the geomembrane.
   3. Have thoroughly dispersed additives throughout rod or bead.
   4. Contain 2 to 3 percent carbon black content.
   5. Be free of contamination by moisture or foreign matter.

2.04 WELDING EQUIPMENT

A. Supplied seam welding accessories must meet the following requirements:
   1. Maintain sufficient operational seaming apparatus to continue work without delay.
   2. Use power source capable of providing constant voltage under combined line load.
   3. Provide protective lining and splash pad large enough to catch spilled fuel under electric generator, if located on liner.
   4. Tensiometers capable of measuring seam strength, calibrated and accurate as per applicable ASTM standards.
   5. Dies for cutting seam samples.

2.05 MANUFACTURER SOURCE QUALITY CONTROL

A. Provide Manufacturers Quality Control Documentation.

PART 3 EXECUTION

3.01 EXAMINATION OF GEOMEMBRANE SUBSURFACE

A. Follow procedures set forth in the QA/QC Plan. No geomembrane shall be deployed without written subgrade acceptance.

B. Grade changes rounded to min. 12-inch radius.

C. Subgrade will be free from rocks or other sharp objects, mounds, depressions, ridges or any anomaly that may cause concentrated stress or puncture the geomembrane.

3.02 PREPARATION

A. Repair damage caused to subgrade during deployment.

B. Prepare anchor trenches as shown in Drawings.

C. Perform trial seam welds as follows:
   1. Perform trial welds on samples of geomembrane to verify the performance of welding equipment, seaming methods, and conditions.
   2. No seaming equipment or welder will be allowed to perform production welds until equipment and welders have successfully completed trial weld.

3. Frequency of trial welds:
    a. Minimum of one trial weld per day prior to the start of work in the morning and one after lunch.
    b. When directed by the QA Personnel.
4. 4Make trial welds in the same surroundings and environmental conditions as the production welds, i.e., in contact with subgrade.
5. Make trial weld sample at least 2 feet long and 12 inches wide with the seam centered lengthwise.
6. Cut six, one-inch wide test strips from opposite ends of the trial weld.
7. Allow coupons (strips) to cool before testing. Testing should be conducted at 70 degrees (plus or minus 4 degrees) Fahrenheit. Coupons temperatures greater than 70 degrees may result in lowered strengths.
8. Quantitatively test specimens for peel adhesion and bonded seam strength. Peel and shear values shall meet or exceed the following:

Material	Shear Strength	Fusion Peel	Extrusion Peel
(Mil)	(PPI)	(PPI)	(PPI)
60	121	98	78

9. A trial weld sample is considered passing when three specimens pass peel and shear tests.
10. Repeat the trial weld in its entirety when any of the trial weld samples fail in either peel or shear.
11. When repeated trial weld fails, do not use welding apparatus and welder until deficiencies or conditions are corrected and two consecutive successful trial welds are achieved.

3.03 INSTALLATION

A. Protection
    1. Do not use geomembrane surface as work area for preparing patches, storing tools and supplies, or other uses. Use protective cover as work surface, if necessary.
    2. Instruct workers about requirements for protection of geomembrane such as handling geomembrane material in high winds, handling equipment, and walking on geomembrane surfaces. Shoes of personnel walking on geomembrane shall be such that they will not damage the liner. Smoking, eating, placing heated equipment directly on geomembrane or other activities that may damage geomembrane is prohibited.
    3. Hold a daily meeting to discuss and coordinate work activities as detailed in the QA/QC Plan.
    4. Do not operate equipment without spark arresters in vicinity of geomembrane material, or place generators or containers of flammable liquid on geomembrane without the use of a splash pad.
    5. Protect geomembrane from vehicular traffic and other hazards.
    6. Keep geomembrane clean and free of debris during placement.

B. Geomembrane Deployment.

1. Give careful consideration to the timing and temperature during deployment. The QC Personnel will focus on verifying that (a) there is no bridging or stresses in the geomembrane and (b) there are no wrinkles in the geomembrane that will fold over when covering with soil material. Ideally, deployment, welding, and covering would all occur at the same temperature. In a practical sense, Contractor should strive to perform these activities within as narrow a temperature range as practical, and avoid these activities during peak hot or cold conditions. Do not deploy geomembrane during precipitation or moisture events (e.g. fog, drizzle, dew), or during excessive wind.
2. Panel Identification: Assign each panel an identifying code number of letter consistent with Contractor's submitted panel layout drawing. The coding should be coordinated with the QA Personnel.
3. Daily Panel Deployment: Deploy no more panels in one shift than can be welded during that same day.
4. Do not deploy in the presence of excessive moisture, precipitation, ponded water, or high winds.
5. Do not damage geomembrane by handling, trafficking, leakage of hydrocarbons or any other means.
6. Install miscellaneous products required to complete geomembrane installation according to manufacturer’s recommendations.
7. Unroll geomembrane panels using methods that will not damage, stretch or crimp geomembrane. Protect underlying surface from damage. Contractor shall be solely responsible for protection of the subgrade. The QC Personnel will verify that the soils underlying the geomembrane are not damaged.
8. Use methods that minimize wrinkles and differential wrinkles between adjacent panels.
9. Temporarily weight geomembrane sheets with sandbags as necessary to anchor or hold them in position during installation. Use continuous hold-downs along edges to reduce wind flow under sheet.
    a. Sandbag fabric shall be sufficiently close knit to preclude fines from working through bags.
    b. Substitution of sandbags with tires or the use of paper bags or plastic lined paper bags is prohibited. Burlap bags may be used if lined with plastic.
    c. Immediately remove damaged or improperly sealed bags from the work area, and clean up the area affected.
10. Anchor edges of geomembrane as shown in Drawings.
11. Protect geomembrane in area of heavy traffic by placing protective cover that is compatible with and will not damage geomembrane.
12. Repair damage to subgrade or other underlying materials prior to completing deployment of geomembrane.
13. Do not allow vehicular traffic directly on geomembrane, with the exception of a low psi, lightweight vehicle such as a 4-wheel ATV or similar equipment.
14. Remove wrinkled or folded material.
15. Visually inspect geomembrane for imperfections. Mark faulty or suspect areas for repair.

16. Install material to account for shrinkage and contraction while avoiding wrinkles. Install material stress-free with no bridging before it is covered. Add material as needed to avoid bridging.
17. Before wrinkles fold over, attempt to push them out. For wrinkles that cannot be pushed out, cut them out and repair cuts at the direction of the QA Personnel.

C. Geomembrane Seam Layout.
   1. Orient seams parallel to line of a maximum slope, i.e., orient down not across slope.
   2. Minimize number of field seams in corners, odd-shaped geometric locations and outside corners.
   3. Keep horizontal seams (seams running approximately parallel to slope contours) at least 6 feet away from toe or crest of slope.
   4. Use seam numbering system compatible with panel number system.
   5. Shingle panels on all slopes and grades as indicated in panel layout drawing.

D. Geomembrane Seam Welding Personnel.
   1. Provide at least one welder (master welder) who has experience welding over 5 million square feet of geomembrane using the same type of welding apparatus in use at site.
   2. Qualify personnel performing welding operations by experience and by successfully passing field-welding tests performed on site.
   3. Master welder will provide direct supervision over other welders.

E. Geomembrane Seam Welding Equipment.
   1. Extrusion welder: Equipped with gauges showing temperatures in extruder apparatus and at nozzle. Temperature at nozzle may be measured by external temperature gauges.
   2. Fusion welder: Automated variable speed vehicular mounted apparatus equipped with devices adjusting and giving temperatures at wedge. Pressure controlled by spring, pneumatic, or other system that allows for variation in sheet thickness. Rigid frame fixed position equipment is not acceptable.
   3. Maintain adequate quality of welding apparatus and spare welders in order to avoid delaying the project.
   4. Use power source capable of providing constant voltage under combined line load.
   5. Keep HDPE feed line clean and free of debris.

F. Geomembrane General Welding Procedures:
   1. Do not commence welding with welding equipment until trial weld test sample, made by that equipment, passes test.
   2. Clean surface of grease, moisture, dust, dirt, debris, or other foreign material.
   3. Overlap panels a minimum 3 inches for extrusion welding.
   4. Do not use solvents or adhesives.
   5. Extend welding to the outside edge of all panels.
   6. If required, provide a firm substrata by using a flat board, conveyor belt, or similar hard surface directly under the weld overlap to achieve firm support.
   7. Provide adequate illumination if welding operations are carried out at night.

8. Cut fishmouths or wrinkles along the ridge of the wrinkle in order to achieve a flap overlap. Extrusion weld the cut fishmouths or wrinkles where the overlap is more than 3 inches. When there is less than 3 inches overlap, patch with an oval or round patch extending a minimum of 6 inches beyond the cut in all directions.
9. Weld only when ambient temperature, measured immediately above, but not in contact with the geomembrane, is between 40°F (5°C) and 104°F (40°C).

G. Geomembrane Defects and Repairs.
1. Examine all welds and non-weld areas of the geomembrane for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of the examination.
2. Repair and non-destructively test each suspect location both in weld and non-weld areas. Do not cover geomembrane at locations which have been repaired until test results with passing values are available.

H. Geomembrane Extrusion Type of Welding.
1. Use extrusion welding only for repairs (e.g., patches, caps) and areas not accessible to fusion welding equipment.
2. Purge welding apparatus of heat-degraded extrudate before welding.
3. Bevel top edges of geomembrane a minimum of 45 degrees and full thickness of geomembrane before extrusion welding.
4. Clean seam welding surfaces of oxidation by disc grinder or equivalent not more than 30 minutes before extruding weld. Change grinding discs frequently. Do not use clogged discs.
5. Do not remove more than 4 mils of material when grinding.
6. Grind across, not parallel to, welds.
7. Cover entire width of grind area with extrudate. Abrasion from grinding shall not extend beyond the area extruded.
8. When restarting welding, grind ends of all welds that are more than five minutes old.

I. Geomembrane Hot Wedge Welding.
1. Place smooth insulating plate or fabric beneath hot welding apparatus after usage.
2. Protect against moisture build-up between panels.
3. If welding cross seams, conduct field test welds at least every four hours.
4. Bevel edges of top and bottom panels on cross seams.
5. Do not weld on geomembrane until equipment has passed trial weld test.
6. Extrusion-weld a repair patch over all seam intersections as described in 3.5.

3.04 FIELD QUALITY CONTROL AND QUALITY ASSURANCE

A. General
   1. Manufacturer, Fabricator, and Installer will participate in and conform to all terms and requirements of the Construction QA/QC Plan, Drawings, and these Specifications. Contractor is responsible for assuring this participation. Quality control and quality assurance requirements are as specified in this paragraph and as presented in the Construction QA/QC Plan. If there is a discrepancy in the construction documents, the order of hierarchy shall be 1) Plans, 2) QA/QC manual, and 3) Specifications.

B. Conformance Testing (Performed by QC with separated equipment).
   1. Perform conformance testing at the rate of 1 QC test per every 20 QA tests.

C. Field Testing (Performed by Installer).
   1. General: Non-destructively test all field seams over their full length using a vacuum test unit, pressure testing, or other approved methods. Perform testing as the seaming progresses and not at the completion of all the field seaming. Complete all required repairs in accordance with this Specification and accepted Industry Standards.
   2. Vacuum Testing.
      a. Equipment, comprised of the following:
         1) A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole, or valve assembly, and a vacuum gauge.
         2) A vacuum pump assembly equipped with a pressure control.
         3) A rubber pressure/vacuum hose with fittings and connections.
         4) A soapy solution and an applicator.
      b. Test Procedures.
         1) Place the box over the area wetted with a soapy solution.
         2) Ensure that a leak-tight seal is created.
         3) Energize the vacuum pump and reduce the vacuum box pressure to approximately 10 inches of mercury (5 psi, gauge).
         4) Examine the geomembrane through the viewing window for the presence of soap bubbles for a period of not less than ten seconds.
         5) All areas where soap bubbles appear shall be marked and repaired in accordance with repair procedures described in this specification.
   3. Pressure Testing for penetrations or other difficult areas not accessible for vacuum testing.
      a. Equipment and Materials.
         1) Bicycle-type pump.
         2) Football-type needle for pumping.
         3) Pressure gauge.

b. Procedures.
    1) Place needle into channel between welds, sealing off the other end of a seam. Pump pressure within seam to 30 psi and hold, recording pressure on pressure gauge.
    2) Hold pressure for at least 5 minutes. As long as the pressure does not drop more than 3 psi, the seam passes.
    3) Before releasing pressure, cut the blockage at the far end of the seam tested. If the pressure releases, the seam can be accepted. If the pressure does not release, there is intermediate blockage and iterative testing is required to verify the actual length of seam tested.

4. Destructive Testing (performed by Installer).
    a. Location and Frequency of Testing.
        1) Collect destructive test samples at a minimum frequency of one test location per average 500 feet of seam length.
        2) Determine test locations during welding. Locations may be prompted by suspicion or excess crystallinity, contamination, offset welds, or suspected defect. QC Inspector will be responsible for choosing the locations.
        3) The QC Inspector may increase the test frequency based on marginal results.
    b. Sampling Procedures.
        1) Cut samples at locations designated by the QC Inspector as the welding progresses. Verify that destructive test results have been obtained before the geomembrane is covered by another material.
        2) QC Inspector will number each sample and mark sample number and location in compliance with the Construction QA/QC Plan.
    c. Immediately repair all holes in the geomembrane resulting from destructive test sampling. Repair in accordance with repair procedures described in this Section. Test the continuity of the repair in accordance with this Section.
    d. Size of Sample: minimum 12 inches wide by 36 inches long with the seam centered lengthwise. Cut a one-inch wide strip from each end of the sample and test these for (shear and peel) in the field. Cut the remaining sample into three parts for distribution as follows:
        1) One portion for Installer: 12 inches by 12 inches.
        2) Two portions to QA Inspector for archive storage and testing: minimum 12 inches by 12 inches.
    e. Field Testing (Performed by Installer)
        1) Test the two, one-inch wide strips specified in paragraph d above by tensiometer for peel and shear, respectively.
        2) Both test strips must meet peel and shear requirements for welded seams specified in this Section.
        3) If any field test sample fails, follow failed test procedures outlined in this Section.

D. Failed Weld Procedures.
   1. Follow these procedures when there is a destructive test failure. Procedures apply when test failure is determined by the QC Inspector or QA Inspector, or by field tensiometer. Follow one of the following two options:
      a. First Option.
         1) Reconstruct the seam between any two passing test locations. (Cannot extrusion weld flap.)
      b. Second Option.
         1) Trace the weld at least 10 feet minimum in both directions from the location of the failed test, or to the end of the weld.
         2) Obtain a small sample at both locations for additional peal and shear tests.
         3) Perform additional peal and shear tests.
         4) If the additional peal and shear tests pass, then reconstruct the weld or cap between the two test sample locations that bracket the failed test location.
         5) If any sample fails, then repeat the process to establish the zone in which the weld must be reconstructed.

E. Acceptable Welded Seams.
   1. Bracketed by two locations from which samples have passed additional peal and shear tests.
   2. For reconstructed seams exceeding 50 feet, a sample taken from within the reconstructed weld passes destructive testing.

F. Seams That Cannot Be Non-Destructively Tested: Perform the following:
   1. If the weld is accessible to testing equipment prior to final installation, non-destructively test the weld prior to final installation.
   2. If the weld cannot be tested prior to final installation, cap strip the weld. The welding and cap-stripping operations must be observed by the QC and QA Personnel for uniformity and completeness.

3.05 REPAIR PROCEDURES

A. Remove damaged geomembrane and replace with acceptable geomembrane materials if damage cannot be satisfactorily repaired.

B. Repair, removal, and replacement is at Contractor's expense if the damage results from Contractor's or Installer's activities or material defects.

C. Repair any portion of the geomembrane exhibiting a flaw, or failing a destructive or non-destructive test. Do not commence welding on liner until trial weld test sample passes trial test. Repair procedures available include:
   1. Patching: Used to repair large holes (over 3/8-inch diameter), tears, pinholes or other minor, localized flaws.
   2. Abrading: Used to repair small sections of seams.
   3. Spot welding or seaming: Used to repair small tears (less than 2 inches long), pinholes or other minor, localized flaws.
   4. Capping: Used to repair large lengths of failed seams.

5. Removing the seam and replacing with a strip of new material.

D. In addition, satisfy the following procedures:
   1. Abrade geomembrane surfaces to be repaired (extrusion welds only) no more than one-half (1/2) hour prior to the repair.
   2. Clean and dry all surfaces at the time of repair.
   3. Extend patches or caps at least 6 inches beyond the edge of the defect, and round all corners of material to be patched and the patches to a radius of at least 3 inches.

E. Verification of repair:
   1. Number and log each patch repair.
   2. Non-destructively test each repair using methods specified in this Section.
   3. Additional destructive tests may be required at the discretion of QA Personnel.
   4. Reconstruct repairs until tests indicate passing results.

3.06 CLEANUP

A. Clean up work area as work proceeds. Take particular care to ensure that no trash, tools, or other unwanted materials are trapped beneath the geomembrane and that scraps of geomembrane material are removed from the work area prior to completion of the installation.

3.07 GEOMEMBRANE ACCEPTANCE

A. Contractor retains all ownership and responsibility for the geomembrane until acceptance by Owner.

B. Owner will accept geomembrane installation when:
   1. All required documentation from the Manufacturer, Fabricator (if applicable), and Installer has been received and accepted.
   2. The geomembrane installation is finished.
   3. Test reports verifying completion of all field seams and repairs, including associated testing, is in accord with the Section.
   4. Written certification documents and drawings have been received by Owner.

END OF SECTION

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SECTION 32 12 16

ASPHALT PAVING

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies paving consisting of aggregate base, asphaltic concrete, and associated materials.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM D1557	Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.5-kg) Rammer and 18-in (457-mm) Drop

B. Testing:
   1. Testing will be conducted by the Construction Manager to determine compliance with the specified degree of compaction and moisture content.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aggregate Base:
   1. Aggregate base shall be Type MA-3, 3/4-inch maximum grading conforming to Section 703 of the ADOT.

B. Liquid Asphalt:
   1. Liquid asphalt for tack coats and treatment of aggregate base shall be Grade MC 250 and shall comply with Section 705 of the ADOT.

C. Asphalt Concrete:
   1. Aggregate shall be Type MA-5, 1/2 inch maximum medium grading, conforming to Section 703 of the ADOT. Asphalt binder shall be paving asphalt, Grade AR-4000, and shall comply with Section 705 of the ADOT. Asphalt concrete mixing and proportioning shall comply with Section 406 of the ADOT.

D. Traffic Line Paint:
   1. Traffic line paint shall be a white latex traffic paint 21209 by Glidden, Vin-L-Stripe acrylic epoxy traffic paint W-801 by Dunn-Edwards, or equal.

PART 3 EXECUTION

3.01 GENERAL

A. Construction shall conform to the details, dimensions and grades specified. Maximum variations in finished grade of paving shall be plus or minus 0.05 feet.

3.02 AGGREGATE BASE PLACEMENT

A. Subgrade:
   1. Areas to be paved shall be graded and compacted in accordance with Section 31 23 00-3.06.

B. Aggregate Base:
   1. Placing of aggregate base shall comply with Section 302-3 of the ADOT. Relative compaction shall be a minimum of 95 percent as determined using methods set forth in ASTM D1557.

3.03 ASPHALT CONCRETE PAVEMENT

A. Asphalt Concrete:
   1. Placement of asphalt concrete pavement shall comply with Section 406.3 of the ADOT. Berms shall be shaped and compacted with an extrusion machine.

B. Tack Coat:
   1. tack coat shall be applied to all vertical surfaces of existing pavement; to curbs, gutters, and construction joints against which asphalt concrete will be placed; to pavements to be surfaced; and where specified at the approximate rate of 0.05 gallons per square yard. Application shall comply with Section 403 of the ADOT. Immediately prior to placing asphalt concrete, additional tack coat shall be applied to areas where the tack coat has been damaged.
   2. Immediately prior to construction of asphalt concrete berms, a continuous tack coat shall be applied to the pavement surface. Application of the tack coat shall not cause a slip or weakened plane between the two joined surfaces.

C. Traffic Line Painting:

1. Traffic lines shall be painted on pavement surfaces where specified. Surfaces are to be free of contaminants that may interfere with adhesion. Thinning and coverage shall be as recommended by the manufacturer, but coverage shall not exceed 400 square feet per gallon. Traffic lines shall be of uniform width with the edges straight and even. Traffic shall be restricted from the area until the paint has dried.

END OF SECTION

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SECTION 33 05 07.13

HORIZONTAL DIRECTIONAL DRILLING

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section specifies Horizontal Directional Drilling (HDD). The Contractor shall furnish all services, including, but not limited to design of proposed alignment, survey of alignment and monitoring of settlement, means and methods and all associated labor, equipment, and materials necessary for pipeline installation, complete and in place. This project consists of multiple 14-inch DR 7 HDPE pipelines to be installed by HDD methods.

B. The Contract Documents identify the minimum requirements, locations, pipe materials and key features that are required for this project. Additional requirements shall include:

1. The exact staging, sequencing, methods, and equipment shall be selected by the Contractor, subject to the requirements of issued permits and the Contract Documents.
2. The bore path geometry shown illustrates a potentially reasonable drive length, depth of cover and separation from known existing features and utilities. The Contractor shall perform a field review of the alignment and may propose modifications to the bore path geometry to optimize their chosen means and methods, and to mitigate risks during installation. The Contractor's proposed alignment, with or without requested modifications, must be verified as compatible with the proposed means and methods, and be submitted for review and acceptance by the Owner's Representative. An increased drill length or depth must consider effects on pumping station hydraulics. Shallower proposed drills must consider quantified hydrofracture, settlement, heave and other potential risks to nearby utilities and surface features that satisfy Owner requirements.
3. HDD Operations shall be continuously monitored and recorded. The pilot hole horizontal and vertical geometry, and annular pressure shall be continuously monitored during drilling and accurately recorded. The minimum increment for recorded, plotted and/or tabulated readings shall be equal to individual drill rod length or 20-foot increments, whichever is less.

C. A qualified HDD Contractor shall perform HDD operations. Contractor shall submit qualifications of the HDD Contractor, and Contractor's Design Engineer per Paragraph 1.05 of this specification. If the HDD Contractor or HDD Design Engineer do not meet the requirements of this specification, the Owner reserves the right to reject them outright and expect the General Contractor to provide alternates that meet the basic experience requirements. Qualification requirements shall remain in force through completion of the HDD Work. Changes to personnel must be submitted in writing for Owner approval prior to engaging in project work.

1.02 PROJECT CONDITIONS

A. SUBSURFACE CONDITIONS

1. Geotechnical Report and Subsurface Investigation are included as an attachment to the Contract Documents.
    a. Geotechnical Engineering Study, Western Navajo Pipeline / LeChee Pipeline, LeChee Arizona June 10th, 2021, and Geotechnical Engineering Study Amendment June 29th, 2022.
2. Reports of subsurface investigations performed by or for the Owner are limited in nature and provide general guidance for the Contractor. The Contractor is responsible for review and interpretation of the geotechnical information and test results and should consider the recommendations contained in those reports as general guidance that should be incorporated into the Contractor's ultimate HDD design and selection of means and methods. The Engineer and Owner makes no guarantee as to the types of materials to be encountered.
3. The Contractor shall perform additional potholing, borings, testing, and exploratory drilling deemed necessary by the Contractor to verify subsurface conditions after Contract Award.

B. EXISTING UTILITIES

1. Contractor shall review and confirm the location of existing utilities prior to commencement of drilling operations. Review shall also include identifying existing trench zones, excavations, abandoned utilities and subsurface features that could provide a route for inadvertent returns and any existing conditions that could negatively impact performance of the guidance system.
2. The Contractor shall contact Local One-Call or other authorized utility marking organization a minimum of 4 weeks before mobilization. Contractor shall maintain One-Call contact records.

1.03 QUALITY ASSURANCE

A. REFERENCES

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
29 CFR Part 1926 –	Occupational Safety and Health Administration (OSHA) Regulations and Standards for Underground Construction
ANSI/NSF Standard 060	Drinking Water Treatment Chemicals - Health Effects
API Specification 5L	Specification for Line Pipe
API Specification 13A	Specification for Oil Well Drilling Fluids Materials for Fresh Water Drilling Fluids
ASTM F1962	Standard Guide for use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossing
TR-46	Guidelines for Use of Mini-Horizontal Directional Drilling for Placement of High Density Polyethylene Pipe
NTUA Std. Drawing W-33	NTUA Std. dwg No. W-33 HDPE Wash Crossing Detail

1.04 SUBMITTALS

A. Submittals shall be provided by the Contractor in accordance with the General Conditions and Submittal Procedures Section 01 33 00.

1. A copy of this specification section, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (☐) shall denote full compliance with a paragraph. If deviations from the specifications are requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a written explanation that reasons the requested deviation. The Owner or Owner's representative shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for requested deviations to the specification requirements shall be sufficient cause for rejection of the entire submittal with no further consideration.

B. Submitted calculations must:

1. Be prepared, signed, and sealed by a licensed professional engineer registered in the project jurisdiction with qualifications per Paragraph 1.05, E of this specification.
2. Identify the source of equations, data and standards used along with values assumed including friction factors, factor of safety, material properties, dimensional properties of the furnished pipe, and project specific parameters such as elevation, drive length, etc.

C. PRECONSTRUCTION SUBMITTALS

1. Submit qualifications and experience records of HDD Contractor and HDD Design engineer if contractor and their engineer is not deemed pre-qualified by Owner:
   a. Submitted documentation to confirm qualifications and experience shall list the five most recently completed Similar Projects performed. The Contractor shall submit additional documentation as needed to demonstrate the requirements for the HDD Contractor and key personnel performing the Work per Paragraph 1.05 of this specification.

b. Project documentation must provide:
    1) the Project Name, Owner, and Contractor Number,
    2) the Owner, and Owner ‘s representatives name, and contact information,
    3) Pipe inside and outside diameter, material, and type (carrier or casing) provided,
    4) subsurface conditions (utilities and geotechnical conditions), and
    5) the total footage planned and completed.

2. Contractor Work Plans per Paragraph 2.04 of this specification.
    a. Include an installation related risk register with mitigation plans.
    b. Include list of contacts and phone numbers of the owners for key utilities or critical structures that may be at risk during the installation.
3. Submit Manufacturer’s product literature and specifications for:
    a. Directional Drilling System and HDD equipment (Drill Rig, etc.) including push and pull and rotational torque and methods for monitoring and measuring utilization of drill rig capabilities
    b. Drilling Steel, including Washover Pipe, if Contractor proposes its use in conjunction with the drilling pipe.
    c. Steering Tools and Down-Hole Tools to be utilized or available for use during drilling, reaming or pull back.
    d. Guidance Control System demonstrating the ability to maintain line and grade to the required tolerances and calibration records for guidance system equipment.
    e. Drilling Fluid Delivery and Recirculation System
    f. Slurry Separation Plant and Equipment
    g. Pipe provided to be installed by HDD:
        1) Pipe information including the pipe inside diameter, outside diameter, pipe material, pipe joint dimensions, manufacturing ASTM, and weight per foot.
        2) Pipe joining methods; fusing, welding, etc.
        3) Pipe minimum bending radius and maximum capacity
        4) Breakaway Links proposed for the pipe proposed
4. Sample of daily logs to be provided during construction, electronic and hard copy, and sample as-built bore path geometry reports and drawings.
5. Drilling Fluid mixes including GHS sheets and product literature for all additives. Literature must demonstrate NSF and environmental compliance.
6. Submit a pipe material Manufacturer’s Letter of Certification that the provided pipe joint is suitable for HDD installation and shop drawings demonstrating allowable deflection, restrain and maximum allowable tensile load for pull back.
7. The CONTRACTOR shall submit the following listed below. Calculations may be by hand, spreadsheet, or other digital format with cited sources or BoreAid software program.
    a. **Bore Path Alignment and Geometry** including entry, exit angles, radius of curves, tangent lengths, stationing, and elevation. Alterations for the Contract Documents must be clearly shown.

b. **Hydrofracture analysis calculations** and recovery plan based on proposed drilling fluid, subsurface conditions, and slurry circulation systems. Recovery plan shall be an emergency response plan for recovery of inadvertent drilling fluid return that includes containment

c. **Settlement risk analysis** and calculations for Contract Document or geotechnical report identified settlement and heave limitations, and/or protection of existing utilities and surface or subsurface features based on Contractor's proposed bore path geometry and anticipated maximum bore hole sizing.

d. **Pipe Stress Analysis** demonstrating the provided pipe is adequate for the service conditions and installation forces including:

1) the maximum anticipated installation loads during start up and steady state pullback, maximum allowable pulling capacity and factor of safety. Calculations shall demonstrate the anticipated loads are acceptable per the manufacturer's design of the provided pipe(s). Calculations shall address tension, bending, and buckling analysis; pullback calculations including pipe capacity, safe pulling tensile stress and duration, fluidic drag, and buoyancy modifications.

e. Drilling, reaming and pullback

1) Submit torque requirements for each pass.

2) Slurry pressure and pullback or thrust forces at the specified minimum increment and at points of minimum cover or inflection for each pass.

f. Drilling Fluid calculations

1) Submit calculations predicting drilling fluid volume, circulation rate and pressure during each pass to predict an inadvertent return for existing subsurface conditions.

2) Submit calculations predicting the volume of spoils removed from the completed borehole to accommodate the carrier pipe installation.

3) Submit estimates of spent drilling fluids for disposal and intended method for disposal including approvals from off-site disposal sources/locations.

g. Separation Plant Sizing

1) Submit calculations predicting the percentage of spoils removed from the completed borehole and demonstrated capacity of the pumping and separation system.

D. CONSTRUCTION SUBMITTALS

1. Record copies of permits
2. Daily Work Logs per Paragraph 2.05 of this specification.
3. The CONTRACTOR shall submit the following calculations:
   a. Submit calculations demonstrating agreement with the actual volume of spoils removed from the completed borehole after reaming has been completed and before pullback of the pipe commences.

E. RECORD INFORMATION

1. Pilot Bore path geometry "As-built" plan per Paragraph 3.07 of this specification.
2. Record Drawings per Paragraph 3.07 of this specification.

1.05 QUALIFICATIONS AND EXPERIENCE

A. **HDD Contractor:** The Contractor performing the Work shall:
   1. be a specialty Contractor for the performance of HDD Installation.
   2. have a minimum of five (5) years' continuous experience and,
   3. Demonstrate experience for:
      a. Three (3) with pipe 12 inches ID or larger with the specified pipe material,
      b. Two (2) of the length or longer required for this project, and
      c. Two (2) in similar subsurface conditions

B. **HDD Superintendent**: Each HDD Superintendent shall:
   1. have a minimum five (5) years experience,
   2. have a minimum three (3) years recent, continuous experience in a Supervisory Role performing HDD installations, and
   3. Demonstrate experience for five (5) example projects, each working in a supervisory role with similar diameters, pullback length and subsurface conditions.

C. **HDD Operators**: Each HDD Operator shall:
   1. have a minimum of five (5) years HDD experience,
   2. have a minimum of three (3) years recent, continuous experience as an Operator on the proposed HDD equipment or similar sized equipment.
   3. Demonstrate experience for five (5) example projects, each working in an operator role with similar diameters, pullback length and subsurface conditions.

D. **Surveyor**: Survey Work shall be supervised by a registered professional surveyor of the state as the project location. The Surveyor shall have experience providing guidance and control for HDD operations. Documentation shall demonstrate a minimum of three (3) projects utilizing the guidance method selected with similar diameter, absolute length and depth below grade and with similar crossings conditions such as controlled rights-of-way, rivers, lakes, or ravines.

E. **HDD Engineer Qualifications**: The Contractor's HDD engineer shall be a professional engineer licensed by the same State as the project location. Experience shall include HDD design, analysis, and preparation of HDD operations within the last five years. Documentation shall demonstrate a minimum of five (5) successfully completed projects of equal or greater bore length, with pipe of equal or greater diameter and in similar subsurface conditions.

1.06 HEALTH AND SAFETY

A. Perform Work in conformance with applicable federal, state, and local safety requirements including noise, light, and work hour restrictions per Owner's requirements.

B. Contractor shall provide attenuation/soundproofing where on-site equipment is operated above the maximum allowable noise tolerances.

C. Provide a common grounding system to the HDD rig to prevent electrical shock in the event of high voltage underground cable strike. The grounding system shall connect all pieces of interconnecting machinery to a common ground. The drill rig shall be equipped with an "electrical strike" audible and visual warning system that notifies the system operators of an electrical strike.

1.07 ACCEPTANCE CRITERIA

A. TOLERANCES
   1. It is the sole responsibility of the Contractor to select the appropriate equipment and methods to meet the specified tolerances. Issues or concerns with tolerances should be addressed during the submittal phase.
   2. The pipe shall be installed to the line and grade of the accepted bore path geometry within the following tolerances:
      a. Vertical tolerance – Plus or minus one (1) foot.
      b. Horizontal tolerance – Plus or minus two (2) feet.
      c. No curve radius shall be less than the manufacturer's recommended/allowable bending radius of the provided pipe.
   3. The Contractor shall be solely responsible for all costs for correction and/or realignment.

PART 2 PRODUCTS

2.01 MATERIAL

A. Coordinate submittals and requirements in A through D. PRODUCT PIPE
   1. Pipe and fittings shall conform to the requirements of NTUA Std. dwg No. W-33 HDPE Wash Crossing Detail and as follows:
      a. Per the drawings; HDPE 14-inch DR 7 with pipe radius and depths shown at pipe stationing per contract drawings.

B. DRILLING FLUID
   1. The Contractor shall select drilling fluids properties such as density, viscosity and gel time based on the subsurface conditions and their means and methods.
   2. Drilling fluid shall be a mixture of bentonite, water and accepted additives or polymers unless otherwise approved.
      a. Bentonite shall be high yielding Wyoming bentonite.
      b. Water shall be potable water.
      c. Additives or polymer may be provided to improve the physical qualities of the drilling fluid and shall be:
         1) ANSI/NSF Standard 060 compliant.
         2) subject to review and acceptance by the Owner's Representative.

2.02 EQUIPMENT

A. DIRECTIONAL DRILLING SYSTEM

1. The directional drilling rig(s) shall:
    a. Be of sufficient capacity to perform the bore, reaming, and pullback of the drilling steel and pipe. Drill rigs shall be equipped with systems to monitor and record pullback pressure.
    b. Have a minimum pulling capacity for the primary rig equal to or greater than 1.2 to 1.5 times the static weight of the entire assembled pipe string.
    c. Include breakaway links between the main swivel and the grip(s) at the pipe, to ensure that the pipelines are installed within allowable load levels. Broken links will require removal of the pipe from the entry end. Each breakaway link rating shall be documented as within the safe pull tensile load of the pipe.

B. DRILLING STEEL

1. Drill steel must be capable of transmitting and withstanding 150 percent of the maximum combined forces of the primary and secondary drill rigs.
2. Washover pipes shall be capable of withstanding same forces as the drilling steel.

C. GUIDANCE SYSTEM AND STEERING TOOL:

1. The Guidance System shall be a north referencing steering tool with supplemental surface calibration, TruTracker, ParaTrack, or equivalent; or a gyroscopic steering system. of sufficient accuracy to maintain alignment within the tolerances specified herein. Selected guidance system shall have proven track record for bore holes of similar depth, length, and through similar soil and rock properties.
2. The system shall provide active steering information to the operator showing the three-dimensional position of the drill tool in relation to the designed alignment. Information shall be continuously recorded and reported as part of the data logs of the project.
3. A downhole pressure monitoring tool shall provide real time pressure measurement of the bore hole annulus.

2.03 SPOILS AND SLURRY HANDLING: NOT USED

2.04 CONTRACTOR WORK AND CONTINGENCY PLANS

A. The Contractor shall prepare a WORK PLAN including the following minimum items:

1. Contact information for key personnel, including but not limited to personnel per Section 1.05 of this specification.
2. A General Plan outlining the procedures and schedule to complete the Work including:
    a. Proposed procedures, equipment, and tools for each phase of the HDD operation
    b. Proposed bore path activities
        1) supporting information for pilot and back ream bore hole sizes, including advance rate and work activity durations for pilot, back ream, and pipe pullback
        2) procedures for monitoring bore path geometry and control
        3) procedures to protect pipe during pullback, including buoyancy modification procedures

4) noise abatement measures for working hours as identified in the Contract Documents

c. Relief holes and conductor casings may be used to relieve excessive pressure down hole and to control inadvertent returns. The Contractor's Work Plan must include the location, materials, and procedures for their use.

d. Pipe joining methods and equipment

e. Disposal plan for drilling fluid and cuttings in accordance with local, state, and federal requirements

f. Traffic control

g. Contingency plan as noted in section 2.04 B.

3. Working Plans illustrating:

a. Bore path geometry to be constructed, including minimum separations to existing features and depths of cover

b. Site layouts for entry and exit pits, staging of materials and equipment and attenuation methods where required

c. Site layout of pipe laydown and assembly areas including staging, inspection, and testing activities and pipe support systems. Pipe support systems should include lift height for the pipe during pullback and identify overhead conflicts and separation distances required.

d. Site Layout of drilling fluid handling, separation plant and storage areas, and

e. Location of environmental protection measures.

4. SPOILS HANDLING Plan:

a. Provide details on the separation plant and drilling fluid pumping systems including dimensions, manufacturer's specifications, pump capacity, noise rating, and soundproofing details. Pump capacity should be specified for water at sea level elevation and adjusted for actual elevation and fluid viscosity.

b. Provide a list of operational parameters to be observed, measured, or recorded and testing requirements to demonstrate the slurry is performing or not performing as intended and that are controlled to prevent inadvertent returns.

c. Provide procedures for modifications to the separation plant and/or slurry additives to attain the intended performance and/or operating parameters.

d. Provide details of measures to contain, transport and dispose of spoils and wasted drilling fluids.

B. The Contractor shall prepare a general CONTINGENCY PLAN and associated risk register to address risks that can be anticipated during performance of the Work. Describe which operational parameters are observed, measured, or recorded so that it can be determined if an event is occurring or has just occurred as follows:

1. HDD Operation

a. If drill steel or carrier pipeline is unable to be advanced or retrieved with the drill rig onsite.

b. If drill tool becomes lost in the hole.

c. If the guidance control system fails to provide accurate information

d. If there is a loss of directional steering information.

e. If there is a loss of steering or the inability to steer.

f. If the installation forces start to increase rapidly, raising concerns about completing the installation.
g. If a swivel breaks during carrier pipe installation
h. Encountering obstructions that may impede the HDD operation
i. Utility strikes
j. Excessive ground settlement or heave.

2. Spoils Separations:
   a. If spoils test positive for hydrogen sulfide and/or petroleum occurrences. Include plan to minimize impacted spoils generation and plan to mitigate any cost and schedule impacts to Construction Manager.
   b. If spoils do not settle/separate with the spoils separation equipment on site.
3. Inadvertent Returns
   a. Submit measures to address response, mitigation, and recovery of inadvertent drilling fluid return (land, water and identified environmentally sensate areas). The plan shall include:
      1) cleanup methods
      2) emergency telephone numbers
      3) sources of equipment, contractors and materials needed for containment and clean-up
      4) corrective actions for reducing operating pressures and modifying the slurry
      5) operating parameter mitigation measures that prevent an inadvertent return
         a) describe which operational parameters are observed, measured, or recorded so that it can be determined if the above is occurring or has just occurred.

2.05 RECORD KEEPING

A. Contractor shall maintain and submit daily Work log to the Owner's Representative at the end of each shift. Daily logs shall include the following minimum information:
   1. Date
   2. Project name
   3. Start and finish times for each crew by shift
   4. Start time of each activity, including down time,
   5. Daily advancement rates, position of the drill head and recorded pressures,
   6. Measurements at the specified increment,
   7. Variations from approved drilled alignment, and
   8. Printed name and signature of the supervisor and operator.

B. Recorded measurements at the specified increment shall include:
   1. Time of measurement.
   2. Surface station, horizontal and vertical position,
   3. Maximum torque, force and direction of force, push or pull.

4. Azimuth, Inclination, and roll.
5. Slurry pressure.
6. Slurry volume per time unit.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall confine construction activities and disturbances to the limits of the accepted Work Area.

B. The Contractor shall provide the Owner's Representative or representatives of permitting agencies access to the Work Area.

C. No excavations deeper than 4 feet shall be performed within 100 feet of the HDD alignment until after pullback is completed except for the following:
   1. Entry and exit pits excavation.
   2. Potholing to locate conflicting utilities, obstacles, or obstructions. Potholed shall be filled with Owner-approved grout if potholing is conducted within 50 feet horizontal feet of the proposed bore path.
   3. Installation of additional monitoring and instrumentation.
   4. Relief Wells as reviewed and accepted.

D. The Contractor shall provide tooling, cutters, drill pipe, mud motor, and drilling fluids based on the anticipated subsurface conditions.

E. Maintain all equipment in good working order. Provide equipment operating with fuel, hydraulic, or lubrication oils with suitable containment basins to contain spilled or leaked fluid. Leaks shall be repaired upon discovery. Any leaking equipment shall not be used until repaired.

3.02 INSPECTION, HANDLING AND ASSEMBLY

A. Pipe, materials and equipment shall be delivered, handled, and stored in accordance with the manufacturer's recommendations. Damaged materials shall not be used.

B. The Contractor shall provide a system of supports and rollers in the pipe build-up and laydown areas during assembly and installation. The pipe shall be protected at all times from impact, abrasion, or excessive bending. Dragging pipe over rough ground, pavement and sidewalks is not allowed.

C. After assembly and prior to pullback, the pipe string shall be visually examined for defects and pressure tested per Paragraph 3.05 of this specification.

3.03 HDD OPERATIONS

A. The Contractor shall maintain a copy of the Contract Documents and Contractor's accepted work plans and submittals on site.

B. Work shall be performed in accordance with the approved submittals and shall not deviate from the approach and tolerances identified in the approved HDD Work Plan without written stamped and signed approval by the Contractor's HDD Professional Engineer and written approval of the Owner.

C. Notify the Owner's Representative of any changes from the accepted submittals prior to implementation or when implementing any contingency measures. Notification shall be made:
   1. Verbally as soon as possible.
   2. By Written notice within 24 hours of event requiring notification.

D. A qualified and approved superintendent and operator must be continually present at the Work Area during drilling, reaming and pullback.

E. Establish and maintain constant communication between entry and exit locations once the pilot hole excavation has commenced and until the pipe is completely pulled into place.

F. The Contractor shall actively monitor the Work Area and alignment for inadvertent returns. If inadvertent returns occur, the Contractor shall immediately implement countermeasures per the approved contingency plan and contact the Owner and Engineer. If the volume of drilling fluid and cuttings exceeds the capacity of the contingency measures, drilling operations shall be discontinued. Drilling shall not resume until contingency plan is implemented.

G. PILOT HOLE DRILLING
   1. At all times during the pilot hole excavation, the Contractor shall:
      a. provide and maintain steering control and guidance that is capable of accurately locating the position of the drill head.
      b. Monitor and record the annular pressure at the specified increment.
      c. Plot the actual horizontal and vertical position of the bore head at the specified increment. This "as built" bore path geometry shall be updated as the pilot hole is advanced and provided in the Daily Reports. The completed as-built plan must be accepted by the Owner's Representative prior to reaming and pull-back.

H. REAMING AND PULL BACK
   1. Use a swivel to connect the pull section to the reaming assembly to minimize torsional stress imposed on the pipes.
   2. Conduct reaming operations to ensure that a hole sufficient to accommodate the pull section or push section has been produced. Any damage to the pipe resulting from inadequate pre-reaming shall be the responsibility of Contractor.
   3. Unless otherwise specified, the pullback shall be conducted in one continuous operation to limit the potential for binding the pipe in the hole.
   4. Install the pipe with counter balancing internal pressure and buoyancy to reduce stress on the pipe including filling the pipe with water or drilling fluid during pull-in. Incremental filling of the carrier pipe during pullback shall be permitted.

5. The tensile load imposed on the pipes during pullback shall not exceed the maximum allowable tensile load established by the Contractor's submittals. Damage to breakaway links shall require removal of the pipe per Section 2.02.A.1.c of this specification.
6. Support the pipe as it proceeds during pull back so that it moves freely and is not damaged due to excessive bending.

3.04 HANDLING DRILLING FLUIDS AND CUTTINGS

A. Provide watertight piping, pumps, storage, containment, and other measures to prevent escape of drilling fluid and cutting. Continuously monitor drilling fluid pumping rate, pressure, viscosity, density, and yield to ensure adequate removal of cuttings and stabilization of the bore hole.

B. The Contractor shall provide and maintain on site sufficient quantities of equipment (graders, shovels, etc.) and materials (such as groundsheets, hay bales, booms, and absorbent pads) for cleanup escaped drilling fluid in the event of an inadvertent return, leak, or spill. Notify the Owner's Representative immediately of inadvertent returns, leaks, or spills.

C. Drilling fluid properties shall be tested and recorded every 4 hours or whenever additions or adjustments are made, to confirm properties are within the desired accepted or manufacturer's performance limits.

D. The Owner reserves the right to sample and monitor the waste drilling mud, cuttings, and water.

3.05 TESTING, INSPECTION AND DISINFECTION

A. Pressure tests shall be performed in accordance with *Section 33 05 36* modified for HDD installation as recommended by the pipe manufacturer.

B. Prior to pullback, the Contractor shall perform the following tests:
   1. Assembled Pipe String Tests
      a. Prior to Pull Back, the assembled string shall be pressure tested. If the pipe string is made up in sections, each section shall be tested.
      b. Defects shall be repaired, and the pipe retested until the pipe passes the pressure test to the satisfaction of the Owner's Representative.
   2. Installed Pipe Testing.
      a. Upon completion of pull-back, allow at minimum of 24 hours for relaxation of the pipe string prior to cutting, testing, or completing connections.
         1) Flush pipes prior to testing using clean water to clear the line, followed by air or cleaning pigs.
         2) Visually inspect exposed pipe outside wall for anomalies such as buckles, dents, out of roundness and other deformations.
         3) Upon completion of successful testing, cut and remove the leading edge of the carrier pipe and inspect for gouges and other damage.
         4) If visual inspection provides areas of concern, Contractor shall provide remedies prior to Owner acceptance and payment.

b. Cap both ends of the pipes to prevent water, soil, and all other foreign material from entering pipes until final connections are made.

c. Pipe disinfection shall be performed in accordance with Section 33 13 06 Disinfection of Water Utility Piping Systems.

3. Final acceptance of the pipe is contingent on the final installation providing the intended pipe capacity. Issues with alignment that adversely impact the hydraulic capacity will be corrected at the contractor's expense. Remedies must be acceptable to the owner and any impacted property owners.

3.06 SITE RESTORATION:

A. Spoils from separation plants, drilling fluids, and cuttings shall be removed from the site and areas cleaned including entry/exit pits such that water will percolate and vegetation restored where required.

B. Remove HDD equipment, materials and waste matter and restore Work Areas to their original condition including replacement of pavement, offsite improvement, and landscaping.

C. Perform additional restoration per requirements of the Contract Documents.

3.07 AS-BUILT AND RECORD DRAWINGS

A. AS-BUILT PILOT HOLE DRAWINGS

1. The Contractor shall submit an as-built plan and profile of the pilot drill within twenty-four (24) hours of completion of the drilling operation. The document shall provide stationing and location, deviations from the accepted bore path geometry, and pressures at the specified increment.
2. The Contractor's Surveyor shall certify the horizontal and vertical location shown and confirm the accuracy of the guidance system used.

B. RECORD DRAWINGS

1. Following completion of the HDD Installation, the Contractor shall provide record plan and profile drawings showing the actual location horizontally and vertically of the installed pipe, deviations from the accepted bore path and locations of final connection points to structures or buried pipes, etc.
   a. Record drawings shall also document utilities or obstacles potholed, relocated or removed.

END OF SECTION

SECTION 33 05 07.24

JACKING OR BORING AND CASING PIPE

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies to use Arizona Department of Transportation (ADOT) Guidelines for Accommodating Utilities on Highway Right-of-Way (Updated August 2015), specifically Section 3.3.10 Jacking or Boring requirements.
   2. This section specifies the minimum requirements for steel casing pipe including the grade of steel, diameter, and cylinder thickness, complete with welded joint ends and pressure grout couplings.

B. Design Requirements:
   1. All Jacking and Boring operations shall conform to the ADOT Guidelines for Accommodating Utilities on Highway Right-of-Way and ADOT permitting requirements. See Appendix I for complete set of Guidelines.
   2. Steel casing shall be provided to the minimum inside diameter, minimum thickness and with the minimum separation between casing and carrier pipe specified.
   3. The CONTRACTOR may select a higher yield strength, greater diameter or thickness based on the installation method and forces as determined by the Contractor at no additional cost to the OWNER.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents: ADOT Guidelines for Accommodating Utilities on Highway Right-of-Way (Updated August 2015). They are a part of this section as specified. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of the reference document shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ADOT Guidelines	Guidelines for Accommodating Utilities on Highway Right-of-Way (Updated August 2015)
ASTM A36/A36M	Standard Specification for Carbon Structural Steel
ASTM A53	SSF Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

Reference	Title
ASTM A283	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A515	Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate and Higher Temperature Service
ASTM A572	Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
AWWA C206	Field Welding of Steel Water Pipe
AWWA C222	Polyurethane Coatings for Interior and Exterior of Steel Water Pipe and Fittings.
AWS D1.1	Structural Welding Code

B. Welding shall be performed by skilled welders, welding operators and tackers who have adequate experience in the type of materials to be used.
   1. Employ only welders qualified under the provisions of ANSI/AWS D1.1 by an independent, local, approved testing agency not more than 6 months prior to commencing Work on the casing or pipeline.
   2. Perform qualification tests using machines and electrodes similar to those to be used in the Work. Provide welding procedures including longitudinal and girth or special welds for pipe cylinders, casing joint welds, reinforcing plates and grout coupling connections.

1.03 SUBMITTALS

A. Procedures: Section 01 33 00.

B. ACTION SUBMITTALS
   1. A copy of this specification section, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (☐) shall denote full compliance with a paragraph. If deviations from the specifications are requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a written explanation that reasons the requested deviation. The Owner (or Owner's representative) shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for requested deviations to the specification requirements shall be sufficient cause for rejection of the entire submittal with no further consideration.

   2. Provide an affidavit of compliance that the pipe conforms to the requirements of this section.

   3. Provide design calculations stamped by a Professional Engineer registered in the State of Arizona that demonstrate the casing pipe to be provided is suitable for in-service conditions (e.g., earth loads, live loads, groundwater, and appropriate surcharge loading) and capable of sustaining the maximum stresses to be imposed during installation.

a. For trenchless casings, provide calculations that consider jacking forces, eccentric forces due to steering, breakout loads, and any other loads that may be reasonably anticipated during construction.
b. Clearly state all load case assumptions and safety factors.

4. Shop Drawings:
   a. Provide Fabrication drawings for the casing pipe including pipe dimensions (spool length, outside, inside diameter, wall thickness, separation between pipe) and welding details.
   b. Provide Shop drawings for grout ports, their location and plug details.

5. Provide Welder Qualifications and field welding procedures including testing.

6. Manufacturer's Product Data and GHS Safety Data Sheets
   a. Shop and Field Applied Linings and Coatings.

7. For prefabricated steel casing pipe:
   a. Submit affidavit of compliance that the proprietary pipe joints/connections are suitable for jacking and can withstand the maximum anticipated jacking load, including breakout loads and joint restraint.

C. INFORMATIONAL SUBMITTALS
1. Provide metallurgical test reports for steel and provide chemical and physical test reports from each sheet of steel that indicate conformance with the specified steel and applicable ASTM requirements.

D. CLOSEOUT SUBMITTALS
1. Provide the surveyed position (x, y, z) of the installed casing at each end based on coordinates as specified by Engineer or Owner. For casings greater than 100 feet in length, provide additional locations at mid-point for each additional 50 feet in length.
2. Provide the casing pipe diameter, thickness, material; lining and coatings, thickness, product, and manufacturer; and appurtenances provided, spacers, end seals, etc. with manufacturer and model.

E. SAMPLES [NOT USED]

PART 2 PRODUCTS

2.01 CASING PIPE MATERIAL

A. Casing pipe shall be shop fabricated with interior seams grounded to a smooth finish. Spiral welding of seams will not be allowed.

B. Pipe shall be specifically designed for jacking or ramming as appropriate to the installation method, and accommodating of a cutting shoe, upsizing components (e.g., weld on reaming heads or swivel assembly), and other ancillary tunneling equipment as appropriate to meet the installation requirements.

C. Steel casing pipe shall, as a minimum, conform to the requirements of ASTM A283, Grade B, C, or D. Minimum yield strength shall be 35,000 psi, and minimum tensile strength shall be 60,000 psi. Provide increased yield strength as required for the maximum anticipated jacking load.

D. Casing section joints are to be butt-welded; lap-welded or welded using butt straps in the field providing watertight field joints. Prepare each end of the casing for butt-welding by providing a ¼-inch by 45-degree chamfer on the outside edges.

2.02 CASING PIPE

A. Pipe shall be manufactured to the following dimensional tolerances:
   1. Roundness: Do not allow the pipe diameter as measured along any single plane to vary more than 1 percent from the specified diameter.
   2. Circumference: Do not allow the outside circumference to vary more than ±1 percent from the nominal circumference based on the specified diameter, or ±3/4-inch maximum.
   3. Wall Thickness: Do not allow the actual wall thickness of the steel pipe sections to vary more than 5 percent under the nominal wall thickness specified.
   4. Straightness: Maximum allowable straightness deviation in any 10-foot length is 1/8 inches. Maximum allowable straightness deviation in fabricated section up to 40 feet in length is 3/8 inches.

2.03 LAYING LENGTHS: MAXIMUM PIPE LAYING LENGTHS SHALL NOT BE LIMITED UNLESS SPECIFIED.PREFABRICATED PIPE WITH PROPREITARY CONNECTORS

A. Prefabricated casing yield strength per requirements of Paragraph 2.01.

B. Prefabricated pipe shall be manufactured to the following requirements:
   1. Pipe shall be manufactured by the rolled and welded cylinder method utilizing the double submerged arc welded process in sections of not less than 8 feet long, except as needed to achieve the final finished length of the pipe.
   2. Manufacturer shall test and certify that one reduced section tension test specimen for each lot of 1,000 feet of each size and wall thickness, shows a tensile strength of not less than 95 percent of the minimum strength specified for the grade of steel used.
   3. Connectors shall be suited of the installation application with flush joints and yield strength of the pipe. Connectors shall be full penetration butt-welded square to ends of section and profiled directly on the finished sections at the option of the manufacturer.
   4. Connectors shall be examined prior to shipment to verify that they are free of injurious defects. Damaged or defective section will be rejected, repaired, or replaced prior to shipping.

C. Evaluate one reduced section tension test specimen for each lot of 1,000 feet of each size and wall thickness to verify tensile strength of not less than 95 percent of the minimum strength specified for the grade of steel used. Complete pipe manufacturing shall be performed at a single pipe producing facility. Partial production at one facility and the completion at another will not be acceptable.

D. APPROVED PREFABRICATED CASINGS
   1. Permalok or OWNER-approved equal.

2.04 GROUT HOLES

A. Provide grout/lubrication ports for all casings that are installed using trenchless methods that are greater than or equal to 36-inches in diameter.
   1. Provide grout holes with 1-1/2-inch minimum diameter opening using Schedule 40 pipe (ASTM A53) with threaded plugs.
   2. Locate holes near the crown and at both sides halfway up between the invert and springline.
   3. Space holes regularly at 10 feet on center. Longitudinal spacing between the connections may be decreased to provide more extensive grouting, but not less than 5 feet.

2.05 PIPE MARKING

A. Mark legibly in English, using English units, the exterior of casing pipe sections with the manufacturer's name, manufacturer's job number, customer name, pipe outside diameter, pipe wall thickness, and pipe weight per foot.

2.06 LINING AND COATING

A. At a minimum, protect pipe inside and out with factory-applied rust inhibitors, or provided with linings and coating as specified.

2.07 CATHODIC PROTECTION – NOT USED

PART 3 EXECUTION

3.01 DELIVERY, STORAGE AND HANDLING

A. Packaging, handling, and shipping shall be in accordance with the manufacturer recommendations.

B. Prior to unloading, inspect each piece visually and note any damage or abnormalities on the carrier's documentation.

C. Use dunnage (or 4'x4's) to stage pieces of casing pipe. Do not lay the pipe on the ground.

D. Do not remove temporary interior casing supports (stulls) until:
   1. Casing pipe is fitted up, aligned, and axially concentric, and tack-welded ready for full penetration welding.
   2. Casing pipe is fitted up, aligned, and axially concentric ready for press-fitting the joint.

3.02 INSTALLATION

A. OPEN CUT

1. Install the steel casing to line and grade as specified in accordance with Section 31 23 00 EXCAVATION AND FILL and Section 31 21 33, Trenching, Backfilling, And Compacting for Utilities.

B. TRENCHLESS INSTALATION
   1. Install the steel casing in accordance with the requirements of ADOT.

C. Install Prefabricated Steel Casing in accordance with the Manufacturer's requirements. Deviations from the recommended procedures shall be provided in the CONTRACTOR's Installation plan

D. Install Carrier pipe and seal the casing.

3.03 WELDING

A. All welding shall be performed by qualified welders in accordance with the requirements of ANSI/AWS D1.1. Welds shall be pre-qualified or qualified by testing.

3.04 TESTING AND INSPECTION

A. Prior to demobilization of trenchless equipment or carrier pipe installation, confirm the installed line and grade of the casing. Provide the surveyed position (x, y, z) of the installed casing for review by the Owner's Representative.

3.05 RECORD DOCUMENTS

A. Provide the surveyed position (x, y, z) of the installed casing at each end based on coordinates as specified by Engineer or Owner.

B. Provide pipe outside diameter (inches), pipe wall thickness (inches), and materials of construction (pipe and protective coatings or linings).

END OF SECTION

SECTION 33 05 25

EXCAVATION SUPPORT SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies requirements for sheeting, shoring, and bracing of trenches greater than five (5) feet in depth. The CONTRACTOR shall provide all labor, equipment, materials, and services necessary.

B. The CONTRACTOR shall design sheeting, shoring, and bracing in accordance with OSHA safety regulations (29 CFR, Part 1926, Subpart P, Excavations) for sloping the sides of excavations, using shoring and bracing, and for using other safety features.

1.02 REFERENCES

A. This Section includes references to the following standards. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements affording the greatest protection to the OWNER shall apply, as determined by the CONSTRUCTION MANAGER.

Reference	Title
APWA	Standard Specifications for Municipal Public Works Construction, Prepared by Arizona State Chapter of the American Public Works Association, latest edition.
MUTCD	Manual on Uniform Traffic Control Devices, United States Department of Transportation, Federal Highway Administration (latest edition)
OSHA	OSHA Safety Regulations (29 CFR, Part 1926, Subpart P. Excavations)
ADOT	Arizona Department of Transportation (ADOT) 2021 Standard Specification and Drawings for Road and Bridge Construction

1.03 SUBMITTALS

A. Submittals in accordance with the General Conditions and Section 01 33 00.

B. Submit design calculations, shop drawings, and detail drawings that demonstrate conformity with OSHA regulations and suitability for design loads and installation methodology. The design shall be stamped and signed by a Registered Professional Engineer of the State of Arizona.

C. Submit shop drawings showing dimensions, elevation, and structural details for each utilized excavation support system. Include on the drawings any required construction sequence, loading, testing, monitoring, and re-bracing/removal requirements. The design shall be stamped and signed by a Registered Professional Engineer of the State of Arizona.

D. Submit excavation plans for worker protection in pipe trenches and other excavations. Submittal of excavation plans shall be for records only. Other than to verify that slide rail shoring is being used, submittals will not be reviewed by the Construction Manager as they are the sole responsibility of the Contractor and the Registered Engineer who signs and seals said plans.

E. Informational Submittals:
   1. Trench excavation plan addressing following topics:.
      a. Details of shoring, bracing, sloping, or other provisions for worker protection from hazards of caving ground.
      b. Design assumptions and calculations.
      c. Methods and sequencing of installing excavation support.
      d. Proposed locations of stockpiled excavated material.
      e. Minimum lateral distance from the crest of slopes for vehicles and stockpiled excavated materials.
      f. Anticipated difficulties and proposed resolutions.
   2. Movement measurement and data and reduced results indicating movement trends.
   3. The excavation support plan and the trench excavation plan shall be sealed by a professional engineer licensed in the State of Arizona.
   4. Stamped Calculations

F. Action Submittals: Name and qualifications of the Professional Engineer(s) registered in the State of Arizona responsible for trench excavation support design.

1.04 DESIGN REQUIREMENTS

A. Design excavation support systems to withstand earth pressures, hydrostatic pressures, bottom heave, equipment loads, applicable traffic and construction loads, and other surcharge loads to allow safe construction without movement or settlement of the ground and to prevent damage to or movement of adjacent structures, streets, and utilities. Design each member or support element with appropriate safety factors.

B. Acceptable excavation support methods include the use of trench boxes, suitable moving support systems, steel sheet pilings, soldier piles and lagging, jet grouted structures, secant pile structures, structural steel wales and struts, liner plates, and timber. If soldier piles are used, insert in predrilled holes. Horizontal strutting below the barrel of a pipe and the use of pipe as support are not acceptable.

C. Provide construction stage loadings for a staged removal of the support system that conforms to the pipe, structure placement, and indicated backfill.

D. Compaction of foundation, bedding, haunching, and backfill shall extend to the undisturbed trench wall during staged removal of the support system.

1.05 QUALITY ASSURANCE

A. Provide surveys to monitor movements of critical facilities.

B. Trench excavation support systems shall be designed by a professional engineer registered in the State of Arizona who has a minimum of 5 years of experience in the design of retaining structures.

PART 2 PRODUCTS

2.01 DESCRIPTION

A. Slide rail shoring is required in several locations along the alignment to navigate steep slopes and cross slopes, protect existing buildings and utilities, and cross the highway. Acceptable slide rail shoring suppliers include the following, or equal:
   1. GME (Griswold Machine and Engineering)
   2. Pro-Tec Equipment, Inc
   3. Efficiency Production, Inc.
   4. SHB, Double Slide Rail, Series 750.

B. Support and protect from damage PacifiCorp poles and foundations and protect power lines. Provide PacifiCorp with calculations and construction methods sufficient to obtain PacifiCorp approval. Address clearances from power lines. Provide a copy of the PacifiCorp-approved special shoring and methods to the Construction Manager. Use PacifiCorp-approved shoring and methods within 30 feet of their poles and foundations

C. Structural Steel: ASTM A36 or better, unless otherwise approved.

PART 3 EXECUTION

3.01 GENERAL

A. Design, provide, and maintain shoring, sheeting, and bracing as necessary to support the sides of excavations and to prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed the Work.

B. Before beginning construction, install, and survey monitoring points as required, adequately protect existing structures, utilities, trees, shrubs, and other existing facilities. The repair of or compensation for damage to existing facilities will be at no cost to the Owner.

C. All welding will conform to the applicable provisions of ANSI/AWS D1.1.

D. Provide, place, and maintain supports, shoring, and sheeting as may be required for sides of excavations. Support excavations in a safe manner in accordance with applicable regulatory safety requirements.

E. The construction of sheeting, shoring, and bracing shall not disturb the state of soil adjacent to the trench and below the excavation bottom.

3.02 SEQUENCE

A. Trench excavation shall not be started until the design for trench support has been accepted by the CONSTRUCTION MANAGER.

3.03 TRENCHES

A. For trench excavation exceeding 5 feet in depth, provide adequate safety system meeting requirements of applicable local construction safety orders, and OSHA requirements.

B. At any time, Contractor's personnel are not present within the immediate vicinity of the Work, open excavations shall be plated, barricaded, or fenced, as necessary, to protect the public and worker safety.

3.04 REMOVAL OF SUPPORT SYSTEM

A. Excavation support shall not be removed until support can be removed without damage to existing facilities, completed Work, or adjacent property.

B. As a minimum, excavation support shall be removed between the existing adjacent surface grade and 5 feet below the adjacent surface grade. As-built Drawings will be prepared showing location of temporary shoring and bracing that remains in place.

C. Excavation support shall be removed in a manner that will maintain support as excavation is backfilled and will not leave voids in backfill. Removal of the support system shall be performed in a manner that will not disturb the pipeline, the compacted backfill, or adjacent construction or facilities.

D. Any void left by shoring system or voids created by the removal of the shoring system will be filled with controlled low strength material (CLSM) or cement grout, as approved by the Construction Manager, to provide soil support between backfill zone and the native soil.

E. Sheet piling removal shall be performed in a manner that will not result in "vibro consolidation" of sandy or granular material below the excavation that could lead to settlement of the pipeline or other works of construction.

F. The support system removed from the excavation shall remain the property of the Contractor and shall be removed from the Site.

END OF SECTION

SECTION 33 05 31

DUCTILE IRON PIPE

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies ductile iron pipe, ductile fittings and gaskets.

B. Definition:
   1. Where cast iron pipe is specified, the term and symbol shall mean ductile iron pipe.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI A21.14	Ductile-Iron Fittings 3 In. Through 24 In., for Gas
ANSI A21.52	Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand Lined Molds for Gas
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings
ASTM A716	Ductile-Iron Culvert Pipe
ASTM C150	Portland Cement
AWWA C104 (ANSI A21.4)	Cement-Mortar Lining for Ductile- Iron and Gray-Iron Pipe and Fittings for Water
AWWA C110 (ANSI A21.10)	Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In., for Water and Other Liquids
AWWA C111 (ANSI A21.11)	Rubber-Gasket Joints for Ductile- Iron and Gray-Iron Pressure Pipe and Fittings
AWWA C115 (ANSI A21.15)	Flanged Ductile-Iron and Gray-Iron Pipe With Threaded Flanges

Reference	Title
AWWA C150 (ANSI A21.50)	Thickness Design of Ductile-Iron Pipe
AWWA C151 (ANSI A21.51)	Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
AWWA C153 (ANSI A21.53)	Ductile-Iron Compact Fittings, 3 In. Through 12 In. for Water and Other Liquids
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C606	Grooved and Shouldered Type Joints

PART 2 PRODUCTS

2.01 GENERAL

A. Pipe design, materials and manufacture shall comply with the following documents:

Item	Document
Thickness design	AWWA C150
Manufacturing requirements	
• Water or other liquid	AWWA C151
• Gas	ANSI A21.52
Gravity service pipe	ASTM A716
Joints	
• Rubber gasket	AWWA C111
• Threaded flange	AWWA C115
Fittings	
• Water or other liquid	AWWA C110/AWWA C153
• Gas	ANSI A21.14
Cement mortar lining	AWWA C104

2.02 PIPE

A. Unless otherwise specified, ductile iron pipe shall be Class 350 and have nominal laying lengths of 18 or 20 feet.

2.03 GASKETS

A. Unless otherwise specified, gasket stock shall be a synthetic rubber compound in which the elastomer is nitrile or neoprene. The compound shall contain not less than 50 percent by volume nitrile or neoprene and shall be free from factice, reclaimed rubber and other deleterious substances. Gaskets shall, in addition, comply with AWWA C111 for push-on and mechanical joints and with AWWA C606 for grooved end joints.

2.04 FITTINGS

A. Unless otherwise specified, fittings shall conform to AWWA C110. Ends shall be flanged, restrained mechanical joint, restrained push-on, or grooved to suit the conditions specified. The AWWA C153 compact ductile iron fittings in sizes 3 through 12 inches are an acceptable substitute for standard fittings unless otherwise specified. Long-radius

elbows shall be provided where specified. Grooved end fittings shall comply with Section 40 05 01-2.01C Fittings and Coupling Compatibility.

2.05 JOINTS

A. Unrestrained Joints:

1. Push-On Joints: Unrestrained joints, where specified, shall be the rubber ring compression, push-on type joint suitable for buried service. Unrestrained joints shall be the Fastite Joint as manufactured by American Cast Iron Pipe Company, the Tyton Joint as manufactured by U.S. Pipe, or equal. This joint is not permitted on fittings or specials, unless otherwise specified. Unless otherwise specified, joints shall have an allowable deflection up to 5 degrees at specified pressures. Joint assembly and field cut joints shall be made in strict conformance with AWWA C600 and manufacturer's recommendations.
2. Mechanical Joints: Where specified, mechanical joints for above or below ground service shall meet the requirements of ANSI/AWWA A21.10/C110 and ANSI/AWWA A21.11/C111. Gaskets and bolts and nuts shall comply with paragraphs 2.03 and 2.05 Bolts and Nuts, respectively.

B. Restrained Joints:

1. General: Unless otherwise specified, restrained joints are required for all exposed and buried piping. Unless otherwise specified, restrained joints shall be flanged or grooved end for exposed service and restrained push-on for buried service.
2. Push-On Joints: Restrained push-on joints shall be as specified in paragraph 2.05 Push-On Joints, modified for restraint. Joints shall be the Flex-Ring or Lok-Ring Joint as manufactured by American Cast Iron Pipe Company, TR Flex Joint as manufactured by US Pipe, or equal. Restrained joints shall be capable of being deflected after full assembly. Joint assembly shall be in strict conformance with AWWA C600 and manufacturer's recommendations. No field cuts of restrained pipe are permitted without prior approval of the Construction Manager.
3. Flange Assemblies: Unless otherwise specified, flanges shall be ductile iron and shall be threaded-on flanges conforming to ANSI/AWWA A21.15/C115 or cast-on flanges conforming to ANSI/AWWA A21.10/C110. Flanges shall be adequate for 250 psi working pressure. Bolt circle and bolt holes shall match those of ANSI B16.1, Class 125 flanges and ANSI B16.5, Class 150 flanges. Where specified, flanges shall be threaded-on or cast-on flanges conforming to ANSI B16.1, Class 250.
    a. Unless otherwise specified, bolts and nuts for flange assemblies shall conform with Section 40 05 06.16-2.01C Bolts. Gaskets shall be as specified in Section 40 05 06.16-2.01B Gaskets.
4. Mechanical Joints: Where specified, restrained mechanical joints shall be the positive restraint type. Mechanical joints with retainer glands are not acceptable.
    a. Locked mechanical hydrant tees, bends and adapters are an acceptable substitute for anchoring fire hydrants and valves to the pipe main.

C. Ball And Socket Flexible Joint Pipe: Ball and socket flexible joint pipe shall be the boltless type and shall allow a maximum joint deflection of 15 degrees. Each joint shall be provided with a retainer lock to prevent rotation after assembly. Joints shall be the Flex-Lok Joint as manufactured by American Cast Iron Pipe Company, USIflex as manufactured by U.S. Pipe, or equal.

D. Bolts and Nuts: Corrosion-resistant bolts and nuts for use with ductile iron joints shall be high-strength, low-alloy steel as specified in ANSI/AWWA C111/A21.11.

2.06 PIPE COATING

A. Unless otherwise specified, pipe and fittings shall be coated with asphaltic material as specified in AWWA C151.

2.07 PIPE LINING

A. Asphaltic Lining: Unless otherwise specified, pipe and fittings shall be lined with asphaltic material as specified in AWWA C151.

B. Cement Mortar Lining: Where specified, interior surfaces of pipe and fittings shall be cement mortar lined in accordance with AWWA C104. Cement shall be ASTM C150, Type II or V, low alkali, containing less than 0.60 percent alkalies.

C. Glass Lining: NOT USED

2.08 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Shop drawings.
   2. Alignment drawings.
   3. Certifications specified in the following documents:
      a. ANSI A21.14, paragraph 14-4.2
      b. ANSI A21.52, paragraph 52-4.2
      c. ASTM A716, paragraph 4.2
      d. AWWA C110, paragraph 10-5.3
      e. AWWA C111, paragraph 11-7.1
      f. AWWA C115, paragraph 15-4.2
      g. AWWA C151, paragraph 51-5.2
      h. AWWA C153, paragraph 53-6.3
      i. AWWA C606, paragraph 4.1.1.1

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Piping runs specified on the drawings shall be followed as closely as possible. Proposed deviations shall be submitted in accordance with Section 01 33 00.
   2. Pipe shall be installed in accordance with AWWA C600.
   3. Connections to existing structures and manholes shall be made so that the finished work will conform as nearly as practicable to the requirements specified for the new manholes, including necessary concrete work, cutting and shaping. Concrete mortar shaping within any structure and manhole shall be as specified.

B. Insulating Sections:

1. Where a metallic nonferrous pipe or appurtenance is connected to ferrous pipe or appurtenance, an insulating section shall be provided as specified in Section 40 05 06.16-3.05.

C. Anchorage:

1. Anchorage shall be provided as specified. Calculations and drawings for proposed alternative anchorage shall be submitted in accordance with Section 01 33 00.

3.02 ACCEPTANCE TESTING

A. Hydrostatic pressure tests shall be conducted in accordance with Section 4 of AWWA C600 except that test pressures and allowable leakage shall be as listed in Section 40 05 01.

B. The Contractor shall conduct the tests in the presence of the Construction Manager.

END OF SECTION

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SECTION 33 05 32

CEMENT MORTAR LINED AND COATED STEEL PIPE

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies cement mortar lined and coated steel pipe and fittings.

B. Design Requirements:
   1. Pipe and fittings shall be designed in accordance with AWWA C200 for the specified pressure and loading. Unless otherwise specified, the design pressure shall be either 100 psi or the test pressure in Section 40 05 01, whichever is greater. Buried pipe and fittings shall be designed for a maximum deflection of 2 percent of the internal diameter for the trench conditions specified plus an imposed wheel load equal to H-20 truck loading. Minimum cylinder thickness shall be 14 gage (U.S. standard) for rubber gasketed joints and 12 gage (U.S. standard) for lap welded joints unless otherwise specified. The diameter specified for pipe and fittings shall be the nominal inside diameter after lining.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
API STD 1104	Welding Pipelines and Related Facilities
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Qualifications
ASTM A36/A36M	Structural Steel
ASTM A283/A283M	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes, and Bars
ASTM A570/A570M	Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
AWWA C200	Steel Water Pipe 6 Inches and Larger
AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe--4 in. and Larger--Shop Applied

Reference	Title
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Service--Sizes 4 in. through 144 in.
AWWA C208	Dimensions for Steel Water Pipe Fittings
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C651	Disinfecting Water Mains
AWWA M11	Steel Pipe--A Guide for Design and Installation

B. Testing:
   1. Factory testing shall conform to the requirements of AWWA C200, except that at the manufacturer's option, fittings and specials not made from hydrotested cylinders may be checked by the dye-penetrant method.

PART 2 PRODUCTS

2.01 PIPE MATERIALS

A. Steel shall conform to the requirements of ASTM A570, Grade 30 or 33, or ASTM A283, Grade C or D, or ASTM A36.

2.02 PIPE MANUFACTURE

A. Pipe shall be straight or spiral seam in accordance with AWWA C200.

B. Complete pipe manufacturing shall be performed at a single pipe producing facility. Partial production at one facility and the completion at another will not be acceptable.

2.03 JOINTS

A. Joints shall conform to the requirements set forth under AWWA C200. Welded joints shall be lap welded in accordance with AWWA C206. Flanges where specified shall be steel plate flanges conforming to AWWA C207.

2.04 FITTINGS AND APPURTENANCES

A. Fittings and appurtenances shall conform to AWWA C208 and shall be designed in accordance with AWWA M11.

2.05 PIPE LINING AND COATING

A. Unless specified otherwise, pipe lining and coating shall be cement mortar in conformance with AWWA C205. Fittings and specials larger than 24 inches, not fabricated from centrifugally lined straight sections, shall require 2 x 4 x 13 gage self-furring wire mesh reinforcement for hand applied lining.

2.06 JOINT GASKETS

A. Joint gaskets shall be as specified in Section 40 05 06.13.

2.07 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. An Affidavit of Compliance with AWWA C200.
   2. Layout schedule.

PART 3 EXECUTION

3.01 PIPE LAYING

A. General:
   1. Pipe shall be provided in accordance with AWWA M11. Welded joints shall be in accordance with AWWA C206.
   2. Sleeve-type mechanical pipe couplings shall be provided in accordance with AWWA M11 and Section 40 05 06.16 of this project manual.
   3. Mechanical joints or push-on O-ring gasket joints shall be provided and assembled in accordance with the manufacturer's instructions.

B. Rubber Gasket Joints:
   1. Rubber gasket joints for cement mortar lined and coated steel pipe shall be assembled in accordance with the manufacturer's instructions. After the joint has been made, the position of the rubber gasket shall be verified. Joints in which gaskets are not properly positioned shall be fully separated, rejointed, and checked. Joints shall be mortared as follows:
      a. Inside Joint Space: For pipe 21 inch diameter and smaller, prior to assembling the joint, the inside shoulder of the bell shall be moistened and "buttered" with a stiff mortar consisting of one part Portland cement to 1-1/2 parts sand. After the joint is assembled, excess mortar shall be removed to provide a smooth and continuous joint surface.
         1) For pipe 24 inch diameter and larger, after the pipe zone bedding and backfill have been completed, the inside joint recess shall be moistened, then filled and pointed with a stiff cement mortar consisting of one part Portland cement to 1-1/2 parts of sand. The finished joint shall be smooth and flush with the adjacent pipe surfaces. Interior joint pointing operations shall not be conducted within two joints of pipe laying operations.
      b. Outside Joint Space: The outside joint space shall be field coated using a cement mortar as follows:
         1) After jointing mortar coated pipe, a cloth or band at least 8 inches in width shall be centered and secured over the exterior joint recess. The band shall be bound to the pipe by the use of steel box strapping or by an equivalent method and shall completely and snugly encase the outside joint except for an opening near the top where mortar grout is to be poured into the joint recess.

2) After the band is properly secured, the joint recess shall be moistened with water and then filled with mortar consisting of one part Portland cement to two parts of sand mixed with water to the consistency of thick cream. The mortar grout shall completely fill the outside annular space between the ends of the pipe and around the complete circumference. After the recess has been filled, the opening shall be closed and the mortar allowed to set before bedding and backfilling at the joint.

C. Welded Joints:
   1. Welded joints or partially welded joints shall be welded by the shielded electric arc method in accordance with ASME Boiler Code (Class I) and API STD 1104. Welded joints shall be mortared as specified for rubber gasket joints.

D. Sleeve and Mechanical Joints:
   1. Sleeve and mechanical joints when buried shall be concrete encased.

3.02 TESTING

A. Hydrostatic testing shall be conducted in accordance with Section 4 of AWWA C600 and the test pressures listed in Section 40 05 01, or 125 percent of the design pressure listed. Unless otherwise specified, allowable leakage shall be as specified in Section 40 05 01.

END OF SECTION

SECTION 33 05 36

HIGH DENSITY POLYETHYLENE PIPE

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section specifies high density polyethylene (HDPE) pipe, fittings, and appurtenances for piping 4 inches to 63 inches in nominal diameter. The designation HDPE is used in the Piping System Specification Sheets (PIPESPEC) in Section 40 05 01 and in this section.

B. Characteristics:

1. The piping system shall conform with the following:

	Volume 3 Pipeline	Volume 1 WTP
Dimension ratio (DR)	DR 7	DR 21
Pressure Class in accordance with AWWA C906	333 psi	125 psi
Minimum radius	20 x Pipe OD	27 x Pipe OD

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

References	Title
ANSI/AWWA C906	Polyethylene (PE) Pressure Pipe and Fittings, 4-inch through 63-inch, for Water Distribution
ASTM D2657	Heat Joining Polyolefin Pipe and Fittings
ASTM D3350	Polyethylene Plastics Pipe and Fittings Material
PPI TR 31	Underground Installation of Polyolefin Piping

B. Inspection and Testing:
   1. All HDPE materials, pipe and fittings shall be inspected and tested in accordance with the requirements of AWWA C906.

C. Affidavit of Compliance:
   1. The manufacturer shall furnish an affidavit of compliance conforming to the requirements of AWWA C906, Section 1.5, affirming that the piping components comply with the requirements of AWWA C906 and this section. The affidavit shall be signed under penalty of perjury by an officer of the pipe manufacturer's company.

1.03 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 00:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. Detail drawings which show the type and location of all fittings, joints, and connections.

PART 2 PRODUCTS

2.01 GENERAL

A. HDPE materials, pipe and fittings shall be manufactured, inspected, sampled and tested in accordance with the requirements of AWWA C906 and this section. In case of conflict between the requirements of this section and AWWA C906, the requirements of this section shall prevail.

2.02 MATERIALS

A. HDPE piping components shall be manufactured from materials that meet or exceed the requirements of the Plastic Piping Institute designation PE4710 and that conform to the requirements of ASTM D3350 for a cell classification of PE 445574C.

B. Bolts and nuts for buried mechanical joining components such as flanges shall be made of noncorrosive, high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any protective coating.

2.03 PIPE

A. Pipe shall have the nominal dimensions shown with an IPS outside diameter basis and the dimensions and tolerances specified in AWWA C906. DR rating and pressure class shall be as specified in paragraph 1.01 Characteristics.

2.04 FITTINGS

A. Fittings shall conform to the applicable requirements of AWWA C906 for the joining methods specified in paragraph 3.02 Joining.

2.05 PIPE MARKINGS

A. Pipe marking shall conform to the requirements of AWWA C906.

2.06 PRODUCT DATA

A. The following product data shall be provided in accordance with Section 01 33 00:
   1. Affidavit of Compliance specified in paragraph 1.02 Affidavit of Compliance.
   2. A report containing a copy of all manufacturer's test results for all tests conducted in accordance with paragraph 1.02 Inspection and Testing.

PART 3 EXECUTION

3.01 PIPE HANDLING AND STORAGE

A. The Contractor shall use care in handling and storage of the pipe. Pipe shall be stored on clean, level ground to prevent undue scratching or gouging of the pipe. If the pipe must be stacked for storage, such stacking shall be done in accordance with the pipe manufacturer's recommendations. The handling of the pipe shall be done in such a manner that it is not damaged by dragging over sharp objects or cut by chokers or lifting equipment.

B. Sections of pipe with cuts, gouges, or scratches on the outside diameter (OD) surface that exceed 10-percent of the wall thickness of the pipe shall be removed completely and the ends of the pipeline rejoined. The inside diameter (ID) surface shall be free of cuts, gouges, and/or scratches.

3.02 INSTALLATION

A. General:
   1. Unless otherwise specified, the piping system shall be installed in accordance with ASTM D2321, AWWA C906 and the manufacturer's recommendations.

B. Joining:
   1. Pipe and fittings shall be joined into continuous lengths on the job site above ground. Unless otherwise specified, joining shall by the butt-fusion method performed in accordance with the pipe manufacturer's recommendations and ASTM D2657. Socket fusion, extrusion welding and hot gas welding shall not be used.

2. The pipe supplier shall be consulted to obtain machinery and expertise for the joining by butt-fusion of HDPE pipe and fittings. No pipe or fittings shall be joined by fusion by any of the Contractor's personnel unless they are adequately trained and qualified in the techniques involved. Butt fusion joining shall yield a joint strength equal to or greater than the tensile strength of the pipe.
3. Flanged joining, or other mechanical joining methods specified, may be used to make connections to differing piping materials, to equipment, valves and other appurtenances, and where specified.

C. Trench Excavation:
1. Trenches shall be excavated to ensure that sides will be stable under all working conditions. Trench walls or supports shall comply with all local and national standards for safety.

D. Location and Alignment:
1. Pipe and fittings shall be placed in the trench with the invert conforming to the elevations, slopes, and alignments shown.

E. Bedding and Backfill:
1. Materials used for bedding and backfill shall be as specified in Section 31 21 33 Trenching, Backfilling and Compacting for Utilities and as shown.
2. Place materials by methods that will not disturb or damage the pipe. All HDPE pipe shall be at the temperature of the surrounding soil at the time it is backfilled and compacted. Work in and tamp the bedding material in the area under the pipe and up to the spring line before placing and compacting the remainder of the embedment. Blocking under the pipe shall not be permitted.
3. Use compaction equipment and techniques that are compatible with materials specified and location in the trench. Before using heavy compaction or construction equipment directly over the pipe, place sufficient backfill to prevent damage, excessive deflections, or other disturbances of the pipe.

3.03 TESTING

A. General:
1. Testing of piping shall be as specified in Section 40 05 01 and this section. In case of conflict, the requirements of this section shall prevail.

B. Hydrostatic Pressure Testing:
1. HDPE piping systems shall be fully pressure tested prior to covering the piping and placing the line into service. Water shall be the test medium for hydrostatically testing the pipe. Test procedures shall be as specified in Section 40 05 01 and the following. In case of conflict, the following procedures shall apply.
2. Cover the pipe at intervals and/or at curves if necessary to hold the pipe in place during testing. Connections shall be left exposed for visual leak inspection.

3. After all free air is removed from the test section; the pressure in the pipe shall be raised at a steady rate to the required pressure. The pressure in the section shall be measured at the lowest point of the test section. Test pressure shall be as specified in Section 40 05 01. The initial pressure shall be applied and allowed to stand without makeup pressure for 2-3 hours to allow for diametric expansion or pipe stretching to stabilize. After the equilibrium period, the test section shall be returned to the required test pressure and held for 3 hours. Amounts of makeup water allowable for expansion during the pressure test shall be as listed in the Plastic Pipe Institute Technical Report TR 31-88. No visual leaks or pressure drops shall be observed during the final test period.

C. Deflection Testing:
   1. General: Deflection testing shall be performed on the entire length of installed pipe no sooner than 30 days after completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads. Deflection of pipe and fittings in the installed pipeline under external loads shall not exceed the maximum deflection specified in paragraph 1.01 Characteristics. Either of the following devices and procedures may be used to measure deflection.
   2. Pull-Through Deflection Testing: The Contractor shall determine whether the allowable deflection has been exceeded by use of a pull-through device.
      a. Pull-Through Device: This device shall be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Circular sections shall be so spaced on the shaft that distance from external faces of front and back sections will equal or exceed diameter of the circular section. Pull-through device may also be of a design promulgated by the Uni-Bell Plastic Pipe Association, provided that the device meets the applicable requirements specified in this paragraph, including those for diameter of the device. Ball, cylinder, or circular sections shall conform to the following:
         1) A diameter, or minor diameter as applicable, equal to the average inside diameter of the pipe minus the dimension equivalent of the maximum installed deflection specified in paragraph 1.01 Characteristics. A tolerance of plus 0.5 percent in the diameter of the test device will be permitted.
         2) A homogeneous material throughout, with a density greater than 1.0 as related to water at 39.2 degrees F, and a surface Brinell hardness of not less than 150.
         3) Center bored and through bolted with a 1/4-inch minimum diameter steel shaft having a yield strength of not less than 70,000 pounds per square inch, with eyes or loops at each end for attaching pulling cables.
         4) Each eye or loop shall be suitably backed with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.
      b. Pull-Through Device Procedure: Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions as specified.

3. Deflection Device: The Contractor shall determine whether the allowable deflection has been exceeded by use of a deflection measuring device.
    a. Deflection Measuring Device: This device shall be sensitive to 1.0 percent of the diameter of the pipe being tested and accurate to 1.0 percent of the indicated dimension. The deflection measuring device shall be approved by the Construction Manager prior to use.
    b. Deflection Measuring Device Procedure: Measure deflections through each run of installed pipe. If deflection readings in excess of the maximum allowable specified in paragraph 1.01 Characteristics are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of the allowable, remove pipe which has excessive deflection, replace with new pipe, and completely retest in the same manner and under the same conditions.

END OF SECTION

SECTION 33 11 13

PUBLIC WATER UTILITY DISTRIBUTION PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes water-distribution piping and related components outside the building for water mains.

B. Related Requirements:
   1. Section 33 13 06 - Disinfection
   2. Section 31 21 33 - Trenching, Backfilling and Compaction for Utilities
   3. Section 31 23 00 – Excavation and Fill
   4. Section 33 05 07.13 - Horizontal Directional Drilling.

1.03 DEFINITIONS

A. EPDM: Ethylene propylene diene terpolymer rubber.

B. LLDPE: Linear, low-density polyethylene plastic.

C. HDPE: High density polyethylene plastic (IPS).

D. PP: Polypropylene plastic.

E. PVC: Polyvinyl chloride plastic.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

B. Field quality-control test reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

1.07 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
   2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
   3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.

D. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

E. NSF Compliance:
   1. Comply with NSF 14 for plastic potable-water-service piping.
   2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The CONTRACTOR shall be responsible for all such material furnished by him and shall replace, at his own expense, all such material found defective in manufacture or damaged in handling after delivery by the manufacturer. This shall include the furnishing of all materials and labor required for the replacement of installed material discovered defective prior to the final acceptance of the Work or during the guarantee period.

B. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
   1. Ensure that valves are dry and internally protected against rust and corrosion.
   2. Protect valves against damage to threaded ends and flange faces.
   3. Set valves in best position for handling. Set valves closed to prevent rattling.

C. During Storage: Use precautions for valves, including fire hydrants, according to the following:
   1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
   2. Protect from weather. Store per manufactures requirements.

D. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

E. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

F. Protect stored piping from moisture and dirt. Elevate above grade.

G. Protect flanges, fittings, and specialties from moisture and dirt.

H. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.09 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
   1. Notify Engineer and Owner no fewer than two days in advance of proposed interruption of service.
   2. Do not proceed with interruption of water-distribution service without Construction Manager's written permission.

1.10 COORDINATION

A. Coordinate connection to water main with the Owner and Engineer. The Contractor shall give the Owner a minimum of 48-hours' notice.

B. Only the Owner personal shall operate existing water valves.

PART 2 PRODUCTS

2.01 PVC PIPE AND FITTINGS (REQUIRED ON POTABLE WATER MAIN)

A. PVC, AWWA Pipe: AWWA C900, DR18 and DR14, with bell end with gasket, and with spigot end.
   1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C153, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
      a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, NSF-61 rubber gaskets, and stainless-steel bolts.
      b. Bituminous exterior coating of 1 mil minimum thickness.
      c. Compact fittings with working pressure of 350 psi to 24-inch and 250 psi to 48"
      d. Restraints: Restraint devices for nominal pipe sizes 3 inch through 48 inch shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10. The devices shall have a working pressure rating of 350 psi for 3-16 inch and 250 psi for 18-48 inch. Ratings are for water pressure and must include a minimum safety factor of 2 to 1 in all sizes. Gland body, wedges and wedge actuating components shall be cast from grade 65-45-12 ductile iron material in accordance with ASTM A536.

2.02 FUSED JOINT POLYETHYLENE (HDPE) PIPE:

A. HDPE pipe shall be used for horizontal directional drilling, See Section 33 05 07.13 - "Horizonal Directional Drilling" for requirements.

2.03 GATE VALVES

A. AWWA, Cast-Iron Gate Valves:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. McWane, Inc.; Kennedy Valve Div.
      b. Mueller Co.; Water Products Div.
      c.
   2. Nonrising-Stem, Resilient-Seated Gate Valves:
      a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
         1) Standard: AWWA C515.
         2) Minimum Pressure Rating: 350 psig.
         3) End Connections: Mechanical joint.
         4) Interior Coating: Complying with AWWA C550.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.
   1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

C. Valve Stem Extensions: Valves with a bury depth of 8 feet or more shall be supplied with a valve stem extension that ends approximately 6-12 inches below finished grade. The extension stem shall be pinned to the valve operating nut. In addition to the valve stem extensions the CONTRACTOR shall provide to the OWNER one (1) Tee handle wrench with a total length of 8 feet and one (1) Tee handle wrench with a total length of 4 feet.

2.04 FIRE HYDRANTS

A. Dry-Barrel Fire Hydrants:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
      a. Mueller Co.; Water Products Div.
         1) Centurion
   2. Description: Freestanding, with one NPS 4-1/2 and two NPS 2-1/2 outlets, 5-1/4-inch main valve, drain valve, and NPS 6 mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
      a. Standard: AWWA C502.
      b. Pressure Rating: 350 psig minimum.
      c. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
      d. Operating and Cap Nuts: Pentagon, 1-1/2 inches point to flat.
      e. Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.

f. Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

2.05 2-INCH FLUSH VALVE

A. Flush valve shall be per NTUA "2" Flush Valve Detail Drawing No. WA-11.DWG".

2.06 WATER SERVICE LINE – NOT USED

2.07 CORPORATION STOPS

A. Furnish 300psig ball valve brass corporation stops with inlet end to suite tapping or service saddle requirements and conductive compression connection outlet for the service line used, type K copper tubing or HDPE DR17. Provide Mueller B25008, Ford FB1000-x-Q, A.Y. McDonald 4701BQ or equal.

2.08 SERVICE CLAMPS

A. Furnish flat, double strap, bronze metal service clamps (service saddles) with neoprene gaskets and corporation stop threads. Assure service clamps for PVC or HDPE provide full support around the pipe circumference with a bearing area of the width along the axis of the pipe so the pipe is not distorted when the clamp is tightened.

2.09 CURB STOPS

A. Furnish curb stops with bronze plug, tee head key with Minneapolis pattern and screw box mount.

2.10 CURB BOXES

A. Furnish extension type curb boxes having a 5-foot extended length.

2.11 INSULATION BOARD:

A. As indicated in the drawings and/or where a minimum depth of 3 feet of cover cannot be maintained over the water line, rigid, extruded polystyrene insulation board is to be provided. The board is to comply with ASTM C578 Type IV. The board shall have a minimum aged R-value per inch of 5.0 per ASTM C518, a minimum compressive strength of 25 psi per ASTM D1621; a maximum water absorption per ASTM C272 of 0.2% by volume, and a maximum linear change according to ASTM D2126 of 3%. The board is to be 2 inches thick with a composite thickness as identified in Table 1 below. The board is to be Dow Styrofoam Brand, or approved equal.

TABLE 1 – INSULATION BOARD COVER

Depth of Backfill over Insulation	Insulation Thickness	Insulation Width
24"	3.0"	5.0'
Less than 36"	2.5"	4.0'

2.12 WARNING TAPE AND REFERENCE MARKER:

A. Warning Tape Warning tape shall have a minimum overall thickness of 5 mils without conductor wires. Tape shall be impervious to all known alkalis, chemical reagents, and solvents found in the soil. Color coding shall be in conformance with the APWA/ULCC Color Code. Warning tape shall have a minimum width of 3 inches for pipe 12 inches and smaller, and a minimum width of 12 inches for larger pipe. The maximum imprint length shall be thirty-six inches. Tape shall be Carsonite Tuff-Tape, or approved equal.

B. Pipeline reference marking posts shall be placed at the State rights-of-way lines and at pipeline appurtenances where indicated on the drawings or details Reference markers shall be color coded to conform to the APWA/ULCC Color Code. Reference posts shall be manufactured by Carsonite International or approved equal.

2.13 CORROSION-PROTECTION PIPING ENCASEMENT

A. Encasement for Underground Metal Piping, Fittings, and Valves:
   1. Standards: AWWA C105.
   2. Form: Sheet or tube.
   3. Material: LLDPE film of 0.008-inch minimum thickness.
   4. Color: Black.

PART 3 EXECUTION

3.01 EARTHWORK

A. Refer to Section 31 21 33 "Trenching, backfilling and compacting for utilities.

3.02 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.

B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

C. Do not use flanges or unions for underground piping unless specified in drawings.

D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

3.03 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Underground Valves, NPS 3 and Larger: AWWA C515 350 NSF 61 350 psi, cast-iron, nonrising-stem, resilient-seated gate valves with valve box.

3.04 PIPING INSTALLATION

A. Water-Main Tank Connections: Construct water main tank connections according to requirements of Owner and of size and in location indicated on the drawings. The Owner and Engineer shall be present to observe all connections to the existing water tanks.

B. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

C. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.

D. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

E. Install pipe following the manufacturer's specifications and instructions. Provide all tools and equipment required to install each type of pipe used.

F. The Contractor is responsible for all contractor furnished material. Replace all defective material or material damaged by handling after delivery by the manufacturer. This includes the furnishing of all materials and labor required to replace installed material discovered damaged or defective before final acceptance of the work, or during the guarantee period.

G. Store all material safely and to prevent damage. Always keep pipe interior and other accessories free from dirt and foreign matter.

H. Deliver and distribute all Contractor furnished pipe at this site. Load and unload pipe, fittings, specials, valves, and accessories to prevent damage. Do not permit pipe handled on skidways to skid or roll against pipe already on the ground.

I. When distributing material at the work site, lay each piece adjacent to its installation point. Repair or replace all damaged pipe at no cost to the OWNER.

J. Remove all water in the trench during pipe laying and maintain a dry trench until the pipe ends area sealed. Do not permit the pipe to float. Do not allow any trench water to enter the pipe at any time.

K. Separation With Sewers: Water mains and water service lines shall be installed to provide at least a 10-foot horizontal separation from any existing sanitary or storm sewer. This distance shall be measured from edge-of-pipe to edge-of-pipe. These requirements include service lines. At crossings, a minimum vertical distance of 18-inches from edge-of-pipe to edge-of-pipe shall be maintained between the water and the sewer pipes. This shall be the case when the water main is either above or below the sewer. At crossings, one full length of water main shall be located so both joints are as far as possible from the sewer.

   1. At all crossings, pipe and backfill shall be properly installed to support the pipes. The material is to be tamped and rodded to fill all voids adjacent to and below both pipes and to compact the fill material.

2. Where the 10-foot horizontal separation cannot be maintained, this separation may be reduced to 5 feet provided the bottom of the water main is at least 18-inches higher than the top of the sewer. Where the requirements for the bottom of the water line to be at least 18 inches higher than the top of the sewer cannot be met, the installation is allowable only if the proposed water line is lowered to at least 3 feet below the invert of the sewer pipe when measured from the top of the waterline pipe.
3. When the required separations between water lines and sewer cannot be met, upon the approval of the Engineer, the sewer may be encased in a minimum of 6 inches of lean concrete or flowable fill around the pipe, extended out a distance of 10 feet on both sides of the crossing. The pipe shall be placed on blocks to allow the lean concrete under the pipe. The pipe shall be fully supported, and stakes used to hold it from lateral movement, to assure it is not displaced during the placement of the lean concrete.
4. Where unusual situations are encountered that make it impossible to follow the requirements of this section a different approach might be required. That approach is to be designed on a case-by-case basis with the design for that particular separation approved by the Owner and the Montana Department of Environmental Quality. The Contractor shall be paid for this particular work as required as a changed site condition.

3.05 JOINT CONSTRUCTION

A. Make pipe joints according to the following:
   1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
   2. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.

3.06 CONNECTIONS TO EXISTING MAINS

A. Make all connections to existing water mains in use unless otherwise specified. Furnish the special fittings, as shown on the plans, and all other material required. Make all necessary excavations to assure gradual transition between the new and existing water main and perform all necessary backfilling.

B. Where the connection of new work to old requires a service interruption and customer notification, the Owner and the Contractor are to mutually agree upon a date for connections to permit adequate time to assemble labor and materials, and to notify all affected customers. All notifications are the Contractor’s responsibility.

C. The Owner will operate all existing valves.

3.07 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints as indicated in the drawings. Anchorages and restrained-joint types that may be used include the following:
   1. Concrete thrust blocks.
   2. Locking mechanical joints.
   3. Set-screw mechanical retainer glands.

4. Bolted flanged joints.
5. Pipe clamps and tie rods.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
   1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
   2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.08 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.

3.09 FIRE HYDRANT INSTALLATION

A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position. Set all hydrants plumb with the pumper nozzle facing the street. Set the hydrant with the ground line at the location indicated by the hydrant manufacturer.

B. AWWA Fire Hydrants: Comply with AWWA M17.

3.10 FIELD QUALITY CONTROL

A. Piping Tests: See Section 33 13 06 Disinfection.

3.11 STERILIZING WATER MAINS:

A. See Section 33 13 06 Disinfection.

3.12 IDENTIFICATION

A. Warning Tape: Install utility warning tape and tracer wire along the entire route of new water main. Install warning tape 18 inches below the finished grade. Install the tracer wire 18 inches above the water main and fire hydrant leads. Install the tracer wire to the ground surface in each gate valve box and physically connect the wire to the inside of each valve box to ensure that the tracer wire does not interfere with insertion or operation of the valve key. Costs associated with furnishing and installing the warning tape and tracer wire shall be merged with the cost for water main installation.

END OF SECTION

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SECTION 33 13 06

DISINFECTION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Requirements for disinfection of all inside surfaces with which potable water contacts.
   2. Requirements for disposal of highly chlorinated water used for disinfection.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. C651 AWWA Standard for Disinfecting Water Mains

1.03 SCHEDULING

A. Schedule and coordinate the work with the Owner. Once disinfection has been satisfactorily accomplished, no further entry to the interior of the facilities will be allowed unless entry must be made to perform repairs and tests, in which case repeat disinfection on a localized basis at no additional cost to the Owner. The Contractor shall be responsible for maintaining security of the disinfected facilities.

B. Disinfect pipelines following successful pressure testing.

1.04 SUBMITTALS

A. Procedures: Section 01 33 00 Submittal Procedures.

B. Submit a Disinfection Plan including the procedures, locations where samples will be collected, methods, materials and schedules proposed for disinfecting the required surfaces, and method of disposal of chlorinated water. Include measures to ensure public safety and proper chemical storage at the disinfection injection point (e.g., paneled fencing, chemical containment, continuous monitoring, etc.).

C. Submit a Warranty Period Maintenance Plan including the procedures for the activity, locations where inspections will be performed, and schedules.

1.05 QUALITY CONTROL AND ASSURANCE

A. Bacteriological samples shall be collected by the Contractor; analyses shall be performed and paid for by the Contracor.

B. Chlorine residual testing shall be performed and paid for by the Contractor.

PART 2 PRODUCTS

2.01 MATERIALS

A. Water: Contractor shall furnish water for testing. See Section 40 05 01. Cost of water and conveyance of the water to the project site is incidental to the Pipeline Cleaning and Testing work.

B. Disinfection Products: Provide in accordance with AWWA C551.

PART 3 EXECUTION

3.01 PREPARATION

A. Provide all necessary appurtenances required for the disinfection procedures including taps, temporary piping, connections and shutoff valves. Submit data on all appurtenances which will be permanently installed.

B. The Contractor is advised that precautions taken to keep surfaces clean during construction and avoiding the entry of deleterious substances on the work during construction will facilitate achieving the disinfection requirements of this project.

C. Prior to disinfecting, thoroughly clean accessible surfaces of dust, dirt, foreign matter and deleterious substances remove any oil by contact with absorbents. Use water sprays, steam cleaning, vacuum cleaning, swabbing, hand brushing or a combination of methods and rinsing to affect the cleaning. Do not use any method that will be detrimental to the finish surfaces. Flush inaccessible surfaces clean.

D. Remove all water used for cleaning.

3.02 APPLICATION

A. After completing all construction activities, disinfect the required surfaces with chlorine solutions in accordance with the following procedures. Following disinfection and flushing, the Contractor shall take water samples for bacteriological analysis of the water. If the specified bacteriological requirements are not satisfied, repeat disinfection procedure until the requirements are met.

B. Pipelines: Disinfection shall be completed in accordance with AWWA C651 and as follows:
   1. Preparation: Flushing and draining connections shall be as needed per the Contractor's developed and Owners' accepted Disinfection Plan. Prior to disinfection, clean or flush the system.
   2. Disinfection procedures for welded steel pipeline shall comply with the slug method, as described in AWWA C651.
      a. When the above procedure has been completed to the satisfaction of the Construction Manager, drain and replace water in the entire system with fresh water until tests at all outlets show a residual of not more than that of the local water supply agency's water.

b. Once the residual requirement has been achieved, drain a portion of the water from the pipeline as approved by the Construction Manager. Small pockets of water shall remain at the low points in the waterline. This water will maintain humidity to minimize cracking of the cement mortar lining.

c. Close all manways, blowoffs, and air valves to maintain the humid conditions inside the waterline.

3.03 FIELD QUALITY CONTROL

A. Chlorine Residual Testing: AWWA C651, DPD Drop Dilution Method, except where otherwise specified. Testing shall be performed by Contractor.

B. Bacteriological Analyses of Water: After the completion of disinfecting procedure, including the final flushing as described in AWWA C651 and heretofore, the Contractor will obtain water samples from this system for bacteriological analyses. Requirements for satisfactory disinfection of water supply are that bacteriological analyses indicate that water samples are negative for coliform organisms, and that Heterotrophic plate count (standard plate count) is less than 100 colony forming units per milliliter. If bacteriological analyses do not satisfy the above requirements, then repeat disinfection procedure until these requirements are met at Contractor's expense.

3.04 DISPOSAL OF DISINFECTION SOLUTION

A. Dechlorinate and dispose of water in accordance with applicable regulations.

3.05 PROTECTION OF DISINFECTED STRUCTURES

A. If required to re-enter a disinfected structure, the work shall be conducted utilizing techniques and work methods as necessary to maintain the disinfected status. This shall include use of disinfected foot coverings, tools, and the like. In the event the Contractor contaminates the facilities, repeat disinfection/decontamination procedures at no additional cost to the Owners.

3.06 PIPE NOT IMMEDIATELY PLACED INTO SERVICE

A. Following acceptance of disinfection testing reports, the pipeline shall be maintained full or partially drained as indicated in the Contract Documents or as directed by the Owners.

B. Apply additional disinfecting chemicals as required to the water to prevent the potential for biological growth.

C. Pipeline shall be sealed to prevent moisture from leaving the closed system and animals or pests from entering the pipeline.

END OF SECTION

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SECTION 33 16 13.13

STEEL ABOVEGROUND WATER UTILITY STORAGE TANKS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section specifies a steel water reservoir including designing, furnishing, constructing, and testing a welded steel tank and accessories for the storage of potable water. Coating systems shall be as specified in Section 09 97 13.33 and cathodic protection as specified in Section 26 42 16.16.

B. Reservoir Design:

1. Reservoir dimensions shall be as specified. Unless otherwise specified, reservoir shall be a ground-supported flat-bottom welded steel tank. It shall have a self-supported dome roof as specified. Design of the tank shall comply with AWWA D100 and Navajo Tribal Utility Authority (NTUA) standards.. The effects of an oscillating water surface in the tank shall also be taken into account. The drawings of the steel reservoir are intended to define general dimensional requirements and tank configuration. Inlet, outlet, and overflow configuration shall be as shown in the drawings. The Contractor shall design the reservoir and all required structural supports and stiffeners in accordance with the requirements contained herein. Design calculations shall be provided in sufficient detail to indicate the procedures used, signed by a structural engineer licensed to practice in the State of Arizona. The reservoir shall be anchored to the concrete pad with stainless steel anchor bolts.

C. Design Criteria: LeChee Water Treatment Plant Tanks

Tank	Raw Water Tank (RWT)	Finished Water Tank (FWT)
• Nominal capacity, mg	0.50	0.35
• Diameter, feet	52	43
• Sidewall Height, feet	32.25	32.25
Roof load, psf	20	20
Wind velocity, mph	115	115
Lowest, one-day mean ambient temperature, degrees F	15	15
Allowable bearing pressure, psf[1]	3,000	3,000

Note:

1. *Includes direct, wind or seismic, and overturning. 1/3 stress increase is allowed for wind and seismic loads.*

1. Roof shall be a self-supported dome roof, with dimensions matching standard draing No. W-20.
2. Annular bottom plates shall be butt welded with a radial width providing at least 24 inches between the inside of the shell and any lap-welded joint in the remainder of the bottom.

D. Seismic Design:

1. General: The Contractor shall apply the approach of AWWA D100, Section 13, modified as specified herein with the following data to determine the minimum strength requirements of the tank for seismic design.
   a. Seismic Design Category C .
   b. Risk Category IV.
   c. Seismic Importance Factor, I_E = 1.50.
   d. Site Class . D
   e. S_{DS} =0.186g ; S_{D1} = 0.051g
   f. Vertical acceleration: Per AWWA D100. Combine with horizontal acceleration. Contractor shall verify.
   g. Freeboard: Contractor to calculate earthquake wave (sloshing) height and adjust height to accommodate design.
   h. Combine hoop stresses by root mean square.
   i. Roof seismic design: Vertical acceleration, percent of horizontal; live load, psf; column lateral dynamic water load, psf; column horizontal acceleration, g
2. Tank Sliding: Positive anchorage to ringwall footing shall be provided where frictional resistance alone is inadequate. Design shall use a coefficient of friction of and include the area under the tank bottom crown for friction resistance area. Two loading cases shall be considered:
   a. Horizontal shear at maximum lateral acceleration and sliding resistance at 0.3 times maximum vertical acceleration.
   b. Horizontal shear at 0.3 times maximum lateral acceleration and sliding resistance at maximum vertical acceleration.
3. Hydrodynamic Seismic Hoop Tension: The impulsive hoop force in pounds per inch shall be calculated from:
   a. For D/H >1.333

$$N_i = 4.5 \times 0.14 \times G \times D \times H \,(Y/H - 1/2\,(Y/H)^2) \,(\tanh(0.866\ D/H)) \quad (1)$$

Where

D = tank diameter, feet
G = specific gravity of fluid
H = height of water, feet
Y = distance below water surface, feet

C, K, S, Z: See AWWA D100 Section 13

   b. Calculate the convective hoop force in pounds per inch from:

$$N_c = 0.975 \times C_1\, ZKS\, GD2\, \frac{\cosh(3.68\,(H - Y)/D)}{\cosh(3.68\ H/D)} \quad (2)$$

c. Calculate the added hydrodynamic force in pounds per inch from:
$N_h \, x \, U_v$

Where

$$N_h = \frac{62.4 \, x \, G}{144} \, x \, Y \, x \, \frac{D}{2} \, x \, 12 = 2.6 \, YDG \quad (3)$$

$$U_v = F \, x \, ZK \, x \, 0.14 \quad (4)$$

F=fraction of horizontal acceleration specified in paragraph 1.01 General.

d. Calculate the hydrodynamic seismic hoop tensile stresses at the bottom of each shell ring by the root mean square combination as shown in AWWA D100 13.3.3.6.

e. Combine hydrostatic and hydrodynamic stresses by:

$$F_c = F_{HS} + \frac{1}{2} F_{HD} \quad (5)$$

Where

Fc = combined stresses
FHS = stress from hydrostatic pressure
FHD = stress from hydrodynamic pressures

f. Verify that combined stresses are less than allowable shell stresses including the one-third increase permitted by AWWA D100 13.3.3.7.4, or increase shell thickness to limit stresses to allowable level in each shell ring. No shell ring shall be thicker than the ring below it.

4. Column Lateral Loads: Design roof columns for lateral forces in addition to vertical loads. Compute equivalent static lateral loads by multiplying column weight by acceleration. Also include lateral force from sloshing water which may be assumed to be 10 pounds per square foot over the projected area of the column. Combine lateral loads with vertical weight of roof structure and live load increased by vertical component of acceleration. Design connections for 1.5 times the calculated forces to provide ductile behavior.
5. Thermal Movement: Design connections of roof rafters to provide for thermal expansion and contraction for a temperature range of 15 to 110 degrees F.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AISI	Pocketbook of AISI Standard Steels
ASTM A36/A36M	Structural Steel
ASTM A283/A283M	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes, and Bars
ASTM D1751	Preformed Expansion Joint Filler for Concrete Paving and Structural Construction
AWWA B300	Hypochlorites
AWWA B301	Liquid Chlorine
AWWA C504	Rubber Seated Butterfly Valves
AWWA C652	Disinfection of Water Storage Facilities
AWWA D100	Welded Steel Tanks for Water Storage
UL 96A	Installation Requirements for Lightning Protection Systems, Ninth Edition
NTUA	Navajo Tribal Utility Authority

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. Qualifications Statements. Provide proof of qualifications in the form of copies of licenses, registrations, and certifications as applicable to the profession of the individual or organization. For Contractor, Contractor's tank design engineer, welders, and independent inspection and testing company, provide name, company name, address, and a description of past experience with work like that to be performed under this contract.

3. List, by product name and number, of standard manufactured items or equipment not fabricated by the tank constructor.
4. Product information, including manufacturer's catalogues, technical data, parts lists, materials lists, operation and maintenance manuals, for standard manufactured items or equipment not fabricated by the tank constructor.
    a. All tank accessories including access hatches, ladders, vents, hatches, etc.
    b. Fall protection equipment.
    c. Piping expansion joints.
    d. Affidavit of compliance with AWWA C221.
    e. Piping support and seismic restraint system components.
    f. Electrical system components.
5. Design Information. Design drawings and calculations shall provide information needed for fabrication, layout and erection. Design calculations shall be in sufficient detail to indicate the procedures used, including the design coefficients, loads and methods. All drawings and calculations shall be sealed by a registered Professional Structural Engineer in the State of Arizona. At a minimum, design drawings shall include the following:
    a. Project location,
    b. Dimensions,
    c. Locations of all access manholes and hatches
    d. Location and design of roof vents
    e. Access ladders and fall protection system
6. Sacrificial anode cathodic protection system
7. Plan of roof penetrations for the cathodic protection facilities.
8. Product Data.
    a. Welding data tabulation and details of welded joints.
    b. Mill test reports of all steel materials with a certification of which ASTM or other AWWA D100 required specification each meets.
    c. Report of initial radiographs and evaluation for each weld as specified in paragraph 3.02 Spot Radiographs.
    d. Report certifying the inspection per Section 11.2, AWWA D100 at the conclusion of the work.
    e. Underwriters Laboratories Inc. Master Label for lightning protection system.
    f. Certificate of compliance with AWWA D100.

PART 2 PRODUCTS

2.01 GENERAL

A. Unless otherwise specified, materials and construction shall conform to AWWA D100. Steel plates shall conform to ASTM A283 and structural shapes shall conform to ASTM A36. Submerged bolts shall be Type 304 stainless steel and all other bolts shall be galvanized unless otherwise noted on the drawings.

2.02 SHELL

A. Shell plates shall be cold rolled to the tank radius prior to the removal of mill scale. Horizontal and vertical joints shall be butt welded on each side with full penetration. If structural bracing of the shell is required, these members shall only be placed on the inside of the shell. Shell plates shall include all vertical plates.

2.03 ROOF, ROOF COLUMNS, RAFTERS, AND GIRDERS

A. Roof plates shall be lap jointed.

B. Roof support system members shall be provided whose slope and layout facilitates cleaning and preparation for application of protective coatings. Columns shall be circular with section properties not less than those of a 6-inch-diameter standard pipe section. The column baseplate shall not be welded to the floor plates but held in position by angles or other stops welded only to the floor plates at ends of a plate diagonal. Shims shall be provided under baseplate to provide uniform bearing where column baseplate overlaps a lap seam in the floor plates.

2.04 ACCESSORIES

A. Shell Manholes and Handholes:
   1. Shell manholes shall be 30 inches in diameter and shall be hinged to the shell. Manholes shall be gasketed and watertight. Handholes for cathodic protection system shall be drilled anode holes in the roof capped with neoprene-gasketed screwed covers.

B. Pipe Connections:
   1. All pipe and pipe connections shall be constructed to the limits specified. Pipe connections shall be provided in the tank bottom per AWWA D100, Section 13.5 and as specified. Penetrations of shell shall not be less than 12 inches clear above bottom. Steel pipe supports for submerged inlet inside the tank shall be provided per pipe length and shall be constructed as recommended by the tank manufacturer.

C. Overflow:
   1. The tank shall have an overflow as specified. The overflow shall be designed for a flow of 700 gallons per minute. Overflow capacity shall be provided with 3 inches of weir crest height.

D. External Ladder:
   1. The tank shall have one external ladder meeting the requirements of AWWA D100, Section 7. The external ladders shall be provided with a Safe-T-Climb device as manufactured by Air Space Devices, Inc., or equal. The exterior ladder shall be carbon steel, painted, and provided with gate with locking mechanism and padlock as shown on the drawings. Ladders shall comply with OSHA and NTUA requirements.

E. Roof Hatch:
   1. The 2' by 2'roof hatch shall be steel with steel hinges and locking hasps. The manufacturer shall provide compression spring operators enclosed in telescopic tubes to provide smooth, easy, and controlled cover operation throughout the entire arc of opening and closing. The hatch opening shall have a 4-inch high curb and the hatch cover shall lap the curb by 2 inches. Roof hatch shall be lockable and be provided with an intrusion sensor/alarm to NTUA's SCADA system.

F. Vent:
   1. A frost free tank vent shall be provided as shown on the drawings. The vent shall contain removable panels with bronze screen and fiberglass insect mesh. Vent shall be designed for tank flowrate of 700 gpm.

G. Platform:
   1. The reservoir shall have a landing platform and handrails at the top of the ladder.

H. Gage Board:
   1. The reservoir shall have a gage board assembly. Gage board assembly shall be a target-reading type liquid level indicator. Gage board assembly shall have an accuracy of plus or minus 1/10 foot.
   2. The indicator shall have an anodized aluminum gage board graduated in feet and tenths and shall extend from the base of the reservoir to the top of the reservoir wall. Gage board shall have black numbers and marks on a white background. The pointer shall be cast iron, colored red, and shall travel in the same direction as the liquid in the reservoir. Pointer shall have two guide wires. Assembly shall have a guided float with two top and bottom anchors, sheave elbows, guides, clamps, and other appurtenances. Sheave anchors shall have a steel housing, adjustable spring rod with cadmium-plated steel spring. Bottom anchor shall be steel. Float and guide wires, pointer guide wires, and wire fasteners shall be 316 stainless steel. Pipe between elbow sheaves and the tank and indicator board shall be 1-1/2-inch galvanized steel. Top of the indicator board shall have an iron cap with a drilled brass bolt guide for guiding the pointer wire. Brackets shall be steel. Indicator shall be equipped with a Type 304 stainless steel pull chain. Gage board shall be Varec 6700 series, or equal.

2.05 FOUNDATION

A. Tank bedding material per tank manufacturer's requirements for corrosion protection and per requirements of the geotechnical report.

PART 3 EXECUTION

3.01 CONSTRUCTION

A. General:
   1. Unless otherwise specified, construction shall conform to AWWA D100.

B. Welding:
   1. Unless otherwise specified, all welding shall comply with AWWA D100, Section 8.

2. Contractor-certified qualification records of the welders employed for erection shall be reviewed with the Construction Manager at the start of erection and each time a new welder is employed. The record for each welder shall indicate:
    a. Date and result of qualification test.
    b. Contractor conducting tests.
    c. Identifying mark of welder.
3. All butt joints shall be provided with complete joint penetration welds.
4. Welding is not permitted when the temperature is less than 32 degrees F, nor during rain, snow, high winds, or when ice is on the metal. For plate thicknesses in excess of 1-1/2 inches, preheating is required when the metal temperature is less than 70 degrees F.

C. Bottom:
1. The reservoir bottom shall be assembled by the lap joint method of construction as specified in Section 8 of AWWA D100, except as required in paragraph 1.01 C. Design Criteria.

3.02 WELD TESTING

A. Spot Radiographs:
1. During erection of the tank shell, spot radiographs in the first 10 feet of joint welded by each welder shall be obtained and evaluated. The radiographs and the evaluation shall be submitted to the Construction Manager within a week after the employment of each welder on the site.
2. A spot radiograph in each 100 feet of shell weld subject to primary stress, and in each 200 feet of shell weld subject to secondary stress, shall be obtained and evaluated. A record of the extent of repair of defective welds and the spot radiographs of repaired joints shall be maintained for review by the Construction Manager on the site and included in the report (per AWWA D100, Section 11.2.1) at job conclusion. After acceptance of the structure, the radiographs or sectional segments shall become the property of the Owner.

B. Vacuum Test:
1. Welded seams of the tank bottom shall be tested for porosity by observation for any bubbles in a soap solution coating with a glass top metal testing box connected to equipment that produces a vacuum of at least 2 psi. This vacuum test shall also be performed on all new welded pipe penetrations on existing steel tanks. Deficient welds shall be corrected.

3.03 TEMPORARY CLOSURE OF TANK OPENINGS

A. Tank openings that are not fitted with valves, hatches, or manhole covers at the completion of erection shall be provided with temporary covers of metal, 10-gage minimum, or plywood, concrete-form quality, cut to fit. Covers shall be installed using three or more bolts. The covers are intended to exclude dust, animals, and intruders before and after painting and after disinfection.

3.04 DISINFECTION

A. Upon completion of reservoir painting, and after the final coat has dried and cured, the reservoir shall be cleaned and disinfected in accordance with AWWA C652 unless otherwise specified. Water for disinfection will be provided by the Owner. The Contractor shall schedule disinfection of the reservoir to coincide with water availability.

B. Prior to disinfection, all interior surfaces shall be washed with clean water using a high-pressure water blaster. All water, dirt, and foreign material accumulated in this cleaning operation shall be discharged from the tank.

C. The tank shall be disinfected with chlorine that conforms to AWWA B300 or B301. A chlorine solution having a chlorine content of 300 mg/l to 500 mg/l shall be sprayed on interior surfaces to be in contact with water when the tank is put into service. The used chlorine solution shall not be drained from the tank during the spraying operation. At the completion of disinfection, the tank shall be partially filled with water to a depth of 1 foot and retained for 4 hours minimum. After the 4-hour period, the chlorinated water shall be drained and squeegeed from the tank and the tank rinsed with potable water.

D. Disposal of chlorinated water to dry land for groundwater recharge.

E. After filling tank but prior to placing tank in service, two samples shall be collected and delivered to a certified laboratory within 6 hours to obtain a bacteriological quality test to demonstrate the absence of coliform organisms. If the initial disinfection fails, water in reservoir shall be chlorinated and retested until satisfactory results are obtained. Retesting shall be at the Contractor's expense. The Contractor shall provide Construction Manager with written test results for submission to the Navajo Nation Environmental Protection Agency (NNEPA).

3.05 TESTING FOR VOLATILE ORGANIC CONSTITUENTS

A. Following disinfection of the tank, but prior to filling the tank for bacteriological testing a 5-day soak test shall be completed to determine the presence of any volatile organic chemicals. The water shall be analyzed by a certified laboratory approved by the NNEPA and the test reports shall be provided to the Owner. The test results shall be approved by the NNEPA and Navajo Tribal Utility Authority (NTUA) prior to final acceptance of the project by the Owner. The reservoir shall then be drained, filled to capacity with potable water, and bacteriological testing completed as specified in paragraph 3.05.

B. Testing for volatile organic constituents shall be as follows:
   1. Contractor shall fill the tank to the overflow level. Potable water for the first test will be provided by the Owner at no cost to the Contractor.
   2. Water shall be allowed to stand for a 5-day soaking period.
   3. The Owner will engage the services of a testing laboratory approved by the NNEPA to perform a total organic scan.
   4. The Construction Manager will obtain a water sample from the tank in accordance with the latest NNEPA procedures and forward the sample to the laboratory for analysis.

5. If levels of the volatile organic contaminants exceed the action levels recommended by the NNEPA Contractor shall drain the tank, cure and force-ventilate the tank for a minimum of 10 days, disinfect, refill, allow to soak, and retest at his expense. This process shall continue until the sample passes. The Owner will deduct the cost of water used to refill the tank from progress payments due the Contractor. The cost of the water will be $1,000 per occurrence.

3.06 GUARANTEE

A. The Contractor shall guarantee its work for a period of two years from the completion date defined in the contract documents to the extent that it will repair any defects caused by faulty design, workmanship or material furnished under the specifications. If Contractor is not advised of any defects within 30 days of end of guarantee period, guarantee shall be considered fulfilled and complete. Defects caused by damaging service conditions such as electrolytic, chemical, abrasive or other damaging service conditions are not covered by this guarantee.

B. All guarantees obtained by the Contractor from the manufacturer or installer of paint, equipment or accessories not manufactured by Contractor shall be obtained for the benefit of the Purchaser.

C. An inspection of the tank systems (including coatings) will be conducted during the month prior to final acceptance of the work by the Owner to determine whether any repair work is necessary. The Owner will establish the inspection date and notify the Contractor. The Owner will drain and wash down the tank. The Contractor shall provide lighting and scaffolding for the tank inspection. Cracking, deformation, misalignments, leakage, rusting, or deterioration of concrete or structural metal shall be considered to be a failure of the elevated tank system. Repairs at failures shall be performed by determining and removing the cause of the failure, and by removing and replacing the failed component or, if authorized by the Owner, correcting the failed component in place by modification and/or reinforcement. Inspection and repairs shall be performed at no additional cost to the Owner.

3.07 LEAKS

A. If any leaks are detected (moisture on the outside of the Tank No. 2) during testing, the Contractor shall promptly repair the leaks by cutting out the defective welds, rewelding, and repairing coatings. Coatings shall be repaired to meet all product, application, and testing criteria for the original coatings.

END OF SECTION

SECTION 40 05 01

PIPING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies the general requirements for design, selection, and supply of pipe materials, fittings, appurtenances, expansion control, supports, and seismic restraints for process, mechanical, plumbing, utility, odor control ducts, and HVAC piping systems. Installation, inspection, and testing are also specified in this Section.

B. Use the general requirements specified in this section with the more specific requirements listed in the Piping System Schedules (Section 40 05 02.00 through 40 05 02.99) and other referenced sections. Except where referenced specification sections specify alternate provisions, the requirements of this Section apply to all piping systems listed in Section 40 05 02.

C. Provide professional engineering services for a piping system design engineer (hereinafter and in all related and referenced sections the "Design Professional") for the design and inspection of piping systems work. For the scope of the work, defined herein as the “Design Professional’s Scope of Responsibility,” the Design Professional provides the design, final inspection, and certification for the piping supports, seismic restraints, and expansion control as specified in this Section and referenced sections.

D. All materials shall be certified for use in drinking water applications in accordance with ANSI/NSF 61.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.

1. Section 01 33 00 Submittal Procedures
2. Section 01 61 45 Area Exposure Designations
3. Section 01 66 00 Product Storage and Handling Requirements
4. Section 01 73 24 Design Requirements for Non-Structural Components and Non-Building Structures
5. Section 03 30 00 Cast-in-Place Concrete
6. Section 31 23 00 Excavation and Fill
7. Section 40 05 02 Piping System Schedules
8. Section 40 05 06.13 Joint Gaskets
9. Section 40 05 06.16 Piping Connections
10. Section 40 05 07 Hangers and Supports for Process Piping
11. Section 40 05 07.13 Seismic Restraints for Piping
12. Section 40 05 07.16 Expansion Control for Piping
13. Section 40 05 45 Piping System Identification

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

Reference	Title
ANSI B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
ANSI B31.1	Power Piping
ANSI B31.3	Process Piping
ANSI B31.9	Building Services Piping
ANSI Z223.1	National Fuel Gas Code
ANSI/ISA-S70.01	Quality Standard for Instrument Air
ASME B1.1	Unified Inch Screw Threads
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Requirements
ASTM F37	Sealability of Gasket Materials
ASTM F104	Nonmetallic Gasket Materials
ASTM F152	Tension Testing of Nonmetallic Gasket Materials
AWWA C651	Disinfecting Water Mains
CAN/CGA B149.6	Code for Digester Gas and Landfill Gas Installations
EJMA	Expansion Joint Manufacturer's Association
UPC	Uniform Plumbing Code

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. Maximum pressure: The greatest continual pressure at which the piping system is designed to operate.
   2. Test pressure: The hydrostatic, air, or gas pressure used to determine system compliance.
   3. Take down coupling: Pipe couplings that facilitate disassembly of piping systems without damage or demolition of piping system components.
   4. Embedded/Encased piping: Piping enveloped in reinforced concrete, typically under structures and under roadways, where specified on the drawings.
   5. Exposed: All area exposures specified in Section 01 61 45 other than buried, submerged, or encased/embedded.

B. Piping System Identification
   1. Process, mechanical, plumbing, utility, odor control, and HVAC piping system piping is identified by a two component alpha-numeric code, (Line Label) as follows:
      a. The first component of the code indicates the nominal line size.
      b. The second component of the code identifies the process Service or fluid being conveyed in the Piping System.
   2. Process Service identifiers for pipelines are specified on the drawings. The Process Service is defined for each Process Service Identifier in Section 40 05 02.

3. Detailed specifications for each Process Service are scheduled in Section 40 05 02.00 through 40 05 02.99.
4. Mark and label Piping Systems as specified in Section 40 05 45.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Refer to Section 40 05 45 for process piping identification requirements.
2. Pipe Sleeves: Coordinate placement of sleeves and penetrations in cast-in-place concrete with raceway, duct, and pipe penetrations prior to concrete placement. Coordinate placement of sleeves and wall penetration prior to construction of masonry building elements.
3. Coordination required with the design of piping supports (hangers, guides, anchors, structural attachments, etc.), expansion joints, and expansion control and seismic restraints. Refer to sections 40 05 06.23, 40 05 07, 40 05 07.13, and 40 05 07.16.
4. Refer to paragraph 1.09 Piping System Design for additional coordination requirements.

1.06 SUBMITTALS

A. Action Submittals:
1. Procedures: Section 01 33 00.
2. Qualifications of the Design Professional charged with inspection and certification of pipe hangers and supports and related scope of work; provide educational background, proof of registration, and proof of insurance and previous experience in performing this type of work. No further submittals under this or any related section will be considered until the Design Professional's qualifications have been reviewed and accepted by the Construction Manager.
3. A copy of this specification section, along with Sections 01 73 24, 40 05 06.23, 40 05 07, 40 05 07.13 and 40 05 07.16, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
4. For each piping system (refer to Piping System Schedules in Section 40 05 02.00 through 40 05 02.99), submit document listing pipe, fittings, linings, coatings, valves, flexible connectors, expansion joints, couplings, bolts, gaskets, restraints, and other items provided for each applicable pipe size and category.

5. Welding: Prior to commencing any welding of steel or stainless steel pipe, supports, and/or structural attachments, provide a written description of welding techniques, including, but not limited to, materials, methods, and quality control. Identify differences in shop and field techniques. Indicate in the submittal that the welding technique has been reviewed for each piping service and certify that the technique is acceptable for the intended service condition (piping service defined in Section 40 05 02 and area exposure designation specified in Section 01 61 45). Written procedures to be stamped and sealed by a Professional Engineer registered in the State of Arizona and qualified for welding design.

B. Informational Submittals:
   1. Procedures: Section 01 33 00
   2. Pre-Construction Data:
      a. Design drawings and calculations for pipe supports, anchorage, seismic restraints, and expansion control systems as specified in Sections 40 05 07, 40 05 06.23, 40 05 07.13, and 40 05 07.16. Drawings and calculations sealed and submitted by the Design Professional specified in this Section. The Design Professional shall affirm that loads on structures are within any stipulated load limits that may be noted on the contract documents.
      b. Submit piping layout drawings for all piping systems, including raceway, duct and other specified systems support. Indicate assembly details, location and placement of field welds, unions and flanges, fittings, valves, flushing connections, drains, sample taps, cathodic protection, seismic restraint system, expansion joints, guides, anchors, hangers, supports, and the provisions for thrust restraint, as well as any other pertinent details and appurtenances for all piping, including wall and floor penetrations, where applicable, in that area. Indicate location and clearances from structures and other utilities (ductwork, conduit, electrical tray, etc.). Include details of connections to new and existing equipment, piping and structures. Submit original layouts by the Contractor; photocopies of Contract Drawings are not acceptable. Identify the invert elevation of buried pipe at changes in slope, pipe crossings, and connections to structures on piping layout drawings in addition to providing coordinates for locating changes in horizontal alignment of buried pipe.
      c. Product Samples: Where specified or when directed by the Construction Manager, provide mill test results or product samples.
      d. Prior to the commencement of welding, submit current and complete documentation of the welder's qualifications.
      e. Safety plans for pneumatic pressure testing.
   3. Post-Construction Data: Inspection reports, authored, sealed, and signed by the Design Professional retained under the provisions of this Section submitted to the Construction Manager. The Design Professional's final report shall be submitted to the Construction Manager before beneficial occupancy by the Owner.

1.07 QUALITY ASSURANCE

1. Review the drawings prior to installation of piping, conduit services, and fixtures. Identify any conflicts and cooperate with the Construction Manager to determine the adjustments necessary to resolve conflicts.
2. Confirm the routing of each section of pipeline with other services prior to commencement of installation. Advise the Construction Manager of any conflicts with existing services or services yet to be installed. Where necessary, amend the routing of pipework to avoid conflict and confirm with the Construction Manager.
3. Refer to paragraph 1.09 Piping System Design for additional quality assurance requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Requirements:
1. Deliver pipe, fittings, and specials to site using loading methods which do not damage pipe or linings, or coatings.
2. Piping materials delivered to site will be clearly marked to indicate size, type, class/schedule and coatings.
3. Until ready for incorporation in the work, store on site as recommended by the piping materials manufacturer to prevent damage, undue stresses, or weathering.
4. Store materials at least 8 inches above ground. Provide sufficient supports to prevent undue bending.
5. Protect non-UV light inhibited plastic from sunlight.
6. Maintain refrigerant piping factory seals until ready for incorporation into the Work.
7. Cover openings in piping, and temporarily seal to protect from contamination.
8. Protect materials and equipment from damage due to environmental conditions. Use protective cover, and protect from surface water by elevating above floor or surrounding grade.
9. Protect unfinished work at end of each workday from damage, contamination and moisture by use of plugs, caps or covers.
10. Protect piping and valves from damage pending performance of system tests.
11. Use proper implements, tools, and facilities for the proper protection of the pipe. Exercise care in the installation so as to avoid damage to pipe, linings, and coatings.
12. Inspect each pipe and fitting prior to installation. Do not install damaged pipe or pipe with damaged protective coatings or linings.
13. Prevent entry of foreign matter during handling, assembling, and installation. Use compressed air, wire brush, solvent and other acceptable means to remove all foreign matter from inside of pipe prior to installation. Remove residual scale, dirt and other foreign matter from interior of piping before final connections are made.

1.09 PIPING SYSTEM DESIGN

A. Design Professional:
   1. Provide professional engineering services ("Design Professional") for the design and inspection of piping systems work. The Design Professional must have not less than ten years' experience in the type of piping support, seismic restraint, and expansion control design work required for this project.
   2. The Design Profession shall be a professional engineer currently licensed to practice in the State of Arizona.
   3. The Design Professional must obtain and maintain professional liability insurance in the amount of $1,000,000 aggregate, to be in effect for the duration of this project plus one year.
   4. The requirements for the Design Professional shall not be construed as relieving the Contractor of overall responsibility for this portion of the work.

B. Piping System Design and Inspection:
   1. The Design Professional shall provide the design, inspection, and certification for piping supports (hangers, guides, anchors, structural attachments, etc.), expansion control and seismic restraints as specified in this Section and referenced Sections.
   2. The work of the Design Professional is complementary to the design elements specified in the Contract Documents and intended to provide complete piping system designs. The Design Professional's inspection responsibilities also complement inspections by the Construction Manager. The division of responsibility for work is shown in the following table:

Piping System Element (Specification)	Design Professional's Responsibility	Construction Manager's Responsibility
Pipe material and thickness, test pressures and other properties (Section 40 05 02.00 through 40 05 02.99)	(NA)	All piping
Contractor layout drawings (Section 40 05 01)	All piping	(NA)
Support design (Section 40 05 07 and Section 01 73 24, and related sections)	All piping, except as indicated for Construction Manager's Responsibility	Pipe supports specified on the drawings
Seismic bracing (Sections 40 05 07.13 and Section 01 73 24, and related sections)	All piping, except as indicated for Construction Manager's Responsibility	Seismic bracing specified on the drawings
Expansion and Control Design (Section 40 05 07.16 and related sections)	All piping, except as indicated for Construction Manager's Responsibility	Expansion Control provisions specified on the drawings
Inspection – General. For design and specification conformance (Section 40 05 01 and related sections)	All piping	(NA)

   3. Acceptable types of supports, guides, saddles, expansion joints, flexible couplings, hangers and structure attachments for general piping support are specified in Section 40 05 07. Seismic restraints are specified in Section 40 05 07.13. Pipe expansion control systems are specified in Section 40 05 07.16. Incorporate these specific elements into the design prepared by the Design Professional.

4. Pipe support and seismic restraint placement is subordinate to the function of anchorage, flexibility, and expansion control provisions. Do not interfere with the function of anchorage, flexibility, and expansion control provisions specified on the drawings.
5. Where pipe anchors are specified, they have been designed for longitudinal (axial) seismic loading, in addition to other longitudinal forces associated with expansion control, and pipe thrust for the associated piping. Rely on the specified anchors for longitudinal seismic bracing of the pipe in these instances.
6. There may be situations where the Construction Manager wants to control where certain anchors are located, the level of forces that can be transmitted to structures, the direction that expansion growth is allowed, or requires use of particular piping elements. In such cases these elements will be specified on the drawings and incorporated into the Design Professional's design. Mandatory anchorage locations identified on the drawings and maximum limitations, if any, for structure loads from the anchor will be as indicated on the drawings, identifying location and the maximum force that can be imposed on the structure. Where structural load would be exceeded, provide piping flexibility or expansion joints to reduce the maximum loading imposed on the structure.
7. For general understanding of intent and bidding purposes, general support locations, arrangements, types and means of attachment may be shown on the drawings. Some of the elements may be specifically designed and detailed. If a particular type of support, anchor, seismic restraint or expansion element is detailed on the drawings, then incorporate those elements into the Contractor's design. Include all elements of the piping system in Piping submittals by the Contractor, including those portions directed by the Construction Manager and complete piping runs.
8. Calculate the structural reaction loads for all fixed supports and indicate the calculated reaction loads on the submitted layout drawings. Notify the Construction Manager if any elements specified on the Drawings are incompatible with the overall piping system and its function.
9. Include consideration of and provisions for:
    a. Support and restrain pipe independent of support or restraint provided by equipment or without equipment supported loads exceeding equipment manufacturer's nozzle loading recommendations. Obtain maximum nozzle loads from the equipment manufacturer.
    b. Routing of pipe to provide access aisles free of obstruction and worker hazards. Unless otherwise specified or approved by the Construction Manager, the minimum clear space between equipment is 36 inches horizontally. Minimum vertical clearance is 7 ft above the floor or local grade at pedestrian access aisles and egress paths. Minimum clearance for equipment access aisles in galleries, tunnels and utilidors is 10 ft by 10 ft.
    c. Electrical bonding for all gas, fuel, and pneumatic conveyance systems.
    d. Dielectric separation, as specified.
10. Include all elements of piping systems required for fabrication and construction in the piping layout submittals. Depict couplings, support, restraint, anchorage, expansion control measures and other elements of the piping system.
11. Depict fitting angles and vertical and horizontal pipe locations, as determined by the Contractor, on piping layout drawings.
12. Do not interfere with maintenance functions and access around equipment, including monorails and hoists.

PART 2 PRODUCTS

2.01 PIPE MATERIALS - GENERAL

A. All pipe materials to be new, free from defects and conforming to the requirements and standards identified in the Piping System Schedules (Section 40 05 02.00 through 40 05 02.99) and related sections.

B. New and existing piping is designated by process service rather than pipe material. Existing pipe material types may not be the same as material types specified for new piping. Investigate connections to existing piping and provide suitable connections, including electrical isolation, as necessary.

C. Fittings and Coupling Compatibility: To assure uniformity and compatibility of piping components, furnish fittings and couplings for grooved-end or shouldered-end piping systems from the same manufacturer.

D. Buried Piping: Size temporary and/or permanent thrust restraints. Design restraint systems to allow complete piping system disassembly without destruction of any portion of the piping system.

2.02 MATERIAL FOR PIPING SUPPORT, SEISMIC RESTRAINTS AND PIPE ANCHORS

A. This paragraph specifies materials for pipe supports specified in Section 40 05 07, seismic restraints specified in Section 40 05 07.13, pipe anchors, certain expansion control elements specified in Section 40 05 07.16, and all associated appurtenances. Section 01 61 45 defines environmental exposures by physical location. Pipe Support, Seismic Bracing, and Pipe Anchor materials are specified based on the environmental exposure specified in Section 01 61 45. Provide Pipe Support, Seismic Bracing and Pipe Anchor components fabricated from materials as specified in the following table:

Environmental Exposure or Pipe Material	Materials [1]	Nuts, bolts, washers, and fasteners
Outdoor	Steel, hot dip galvanized after fabrication	Type 304/316 stainless steel
Indoor, Dry	Steel, hot dip galvanized after fabrication	Steel, Zinc plated or hot-dip galvanized after fabrication
Indoor, Wet	Type 316 stainless steel or FRP	Type 316 stainless steel
Chemical Corrosive	Fiberglass (FRP)	Type 316 stainless steel
Head Space	Type 316 stainless steel or FRP	Type 316 stainless steel
Submerged	Type 316 stainless steel or FRP	Type 316 stainless steel
Undefined	Type 316 stainless steel or FRP	Type 316 stainless steel
Stainless steel piping	Same type of stainless steel as the pipe or FRP	(per area as defined in this table)

Notes:

1. *Where materials as designated in drawing details or indicated in other specification sections, those requirements govern over the provisions of this table.*

2.03 PIPE AND VALVE COMPATIBILITY

A. Coordinate the selection of pipe materials, linings, and end connections so that valves operate properly over their entire range (e.g., sufficient disk clearance for butterfly valves). Support wafer style valves or spectacle flanges between flanges of equal inside diameter.

2.04 BONDING JUMPERS

A. Provide plated, flexible copper braid jumpers with unplated copper ferrules for attachment to pipe flanges, rated for a 100 amp minimum. Provide Burndy Electrical, Type B series, or Approved Equal, and sufficient conductive, anti-oxidant compound (Burndy Electrical Penetrox series or Approved Equal) to protect ferrules.

2.05 JOINTS – GENERAL

A. Provide joints for disassembly within 3.0 ft of any connection to equipment, on both sides of structural penetrations, and within 2.0 ft of all threaded end valves.

B. Unless otherwise specified on the drawings or in equipment specifications, adapt all equipment connections to a flanged connection compatible with the connected piping system.

C. Flexible Joints at Structural Joint Crossings: Provide a flexible joint (or joints) on all piping crossing structural joints.

2.06 FLANGES AND OTHER COUPLINGS

A. Pipe connections are specified in the Piping System Schedules in Sections 40 05 02.00 through 40 05 02.99.

B. General requirements for flanges are as follows:
   1. Where raised-face and flat flanges are provided for connection, reface the raised-face flanges. Flange face to be flush with flat-faced companion flanges on flat-faced valve or equipment flanges.
   2. Provide flat-faced flanges on each side of butterfly valves.
   3. For steel piping, provide weld neck flanges on both sides of wafer or lug body valves.

C. Slip-on flanges that are attached to a pipe by means of set screws and gaskets (uni-flange, etc.) are not acceptable.

2.07 FITTINGS – GENERAL

A. Fittings are specified in the Piping System Schedules.

B. Provide eccentric reducers in horizontal lines with the flat side on top, unless specified otherwise on the drawings (e.g., flow meters in horizontal runs requiring submergence).

C. Provide concentric reducers in vertical lines, unless otherwise specified on the drawings.

D. Provide reducers upstream and downstream of flow measurement devices to adapt line size to the specified flow measurement device dimension. Coordinate with the specific instrument requirements.

E. Provide long radius (greater than or equal to 1.5 x nominal diameter) elbows unless otherwise specified on the drawings.

2.08 GASKET MATERIALS

A. For flat faced flanges, use full-face gaskets. For raised-face flanges, use ring type gaskets. Conform to ANSI B16.21.

B. All gasket materials shall be certified for use in drinking water applications in accordance with ANSI/NSF 61.

C. Refer to the Piping System Schedule for the specified gasket material. Material designations used in the detailed pipe specification sheets are as follows:

1. EPDM: ethylene-propylene-diene-terpolymer 70 durometer
2. Neoprene: neoprene (black) 70 durometer
3. Nitrile: nitrile (Buna N)
4. SBR: Styrene-butadiene (red)
5. Natural rubber: natural rubber
6. Compressed synthetic fibers (Kevlar): ASTM F104 (F712400), and neoprene binder: 1.7 MPa (ASTM F152), 0.2 mL/h Leakage Fuel A (ASTM F37)
7. Compressed synthetic fibers (Kevlar): ASTM F104 (F712400) and SBR binder: 1.7 MPa (ASTM F152), 0.1 mL/h Leakage Fuel A (ASTM F37)
8. Gylon - Type 1: Garlock Style 3500: 1.35 MPa (ASTM F152), 0.22 mL/h Leakage Fuel A (ASTM F37)
9. Gylon - Type 2: Garlock Style 3510: 1.35 MPa (ASTM F152), 0.04 mL/h Leakage Fuel A (ASTM F37)
10. CPE - Chlorinated Polyethylene
11. Spiral-wound: per ASME B16.20, rated to 1200 degree Fahrenheit Flexitallic SS316L or approved equal
12. PTFE bonded EPDM, full-face gaskets
13. Viton/FKM – Fluoroelastomer, 75 Durometer

2.09 DISSIMILAR METAL CONNECTIONS

A. Where dissimilar metals are to be connected, provide dielectric fittings and/or isolating flanges, including bolt sleeves and washers, according to Section 40 05 06.

2.10 CATHODIC PROTECTION

A. Provide cathodic protection of piping, pipe fittings, and appurtenances where specified on the drawings.

2.11 STRUCTURAL ELEMENT PENETRATIONS

A. Penetrations through structural elements are referenced to a custom detail or Standard Detail. Where a penetration detail is not specified, conform to the Standard Detail relevant to the type of structure, exposure, and type of pipe.

B. Provide pipe sleeves capable of supporting the loads applied during placement of concrete or during block work erection.

2.12 PIPE MARKERS, DETECABLE WARNING TAPE, AND TRACER WIRE

A. Pipe marker, detectable warning tape, and tracer wire materials per Section 40 05 45.

PART 3 EXECUTION

3.01 PREPARATION

A. Prior to installation, inspect, and field measure to ensure that previous work is not prejudicial to the proper installation of piping.

B. Pothole existing pipe at connections to new pipe to confirm material and joints prior to submittal of pipe layout drawings.

C. The Drawings are, in part, diagrammatic, make all minor modifications to suit installed equipment and structural element locations and elevations and coordinate with electrical construction.

D. Provide details of connections to new and existing equipment, piping, and structures in piping layout drawing submittals. Unless otherwise specified on Drawings, piping fitting angles and vertical and horizontal pipe locations shall be determined by Contractor.

E. Piping arrangements indicated on the drawings have been estimated from the approximate configuration of the type of equipment listed in the equipment specifications. If the equipment to be provided does not have the same configuration, modify the piping arrangement as necessary. Include any piping modifications in shop drawings submitted prior to fabrication or installation.

3.02 PIPE SUPPORT, ANCHORAGE, AND SEISMIC BRACING

A. Support piping with anchor brackets, guides, saddles, or hangers. Pipe movement due to thermal expansion and internal pressure and dynamic forces shall be accommodated by pipe springing, anchors, expansion joints, and guides selected for the specific purpose by the Design Professional retained under the provisions of this Section. Provide supports on each run at each change of direction.

B. Provide seismic bracing as required to resist seismic loads.

C. Do not use existing pipes and supports to support new piping. Existing tunnel pipe support racks can be used for new pipe if the Design Professional determines that the existing rack components are adequate to support the additional load.

D. Install expansion loops, anchors, expansion joints, and guides where specified on the drawings.

3.03 PIPING CONNECTIONS TO MACHINES

A. Align piping at machine connections in all planes to permit insertion of bolts at bolted connections or coupling screwed connections without using jacks, come-a-longs or other mechanical means to align field piping with the connections at the machines.

B. Do not force bolts into mating flange bolt holes. Align flange bolt holes to permit insertion of bolts by hand (without tools, hammering, or prying).

C. Use of 'dutchmen' mitered sections or similar specials to achieve the required alignment with machine connections are strictly prohibited.

D. Provide equipment connection fittings per Section 40 05 06 as specified on the drawings.

3.04 JOINT AND COUPLING OPTIONS

A. Provide pipe connection (joint and coupling) options as specified in the Piping System Schedule.

B. If a Piping System Schedule lists several connection options, then any of the listed options may be used for a particular pipe material, but the selected option shall be used consistently. For example, if flanged or grooved connections are specified and grooved are represented on the Drawings, then flanged may be installed in lieu of the grooved couplings specified on the drawings.

C. Connecting straight runs of pipe by welding is acceptable only where the individual Piping System Schedule allows welding as a connection option.

D. Where connections other than those indicated on the Piping System Schedule are specified on the Drawings, locate the connection specified on the drawing at the specific location indicated on the drawing.

E. Provide rigid, non-rotating connections at all valves and equipment.

3.05 SMALL BORE UTILITY PIPING

A. Field route small bore (generally less than 3-inch) diameter branch piping for utility services.

B. In general, small bore utility branch piping is not specified on the Drawings unless a specific pipe routing or configuration is to be provided or where necessary to show valves or instrumentation requiring electrical connections.

C. Distribution lines for small bore utility piping are specified on the Drawings along with service connection routes to locations that require utility service piping.

D. Install small bore utility piping that must be drained to provide freeze protection with a continuous slope down to the drain.

3.06 BONDING

A. Bonding jumpers shall be as specified in this Section.

B. Bonding shall be provided for all gas, fuel, and pneumatic conveyance systems to control static electricity. Provide bonding jumpers to the following piping systems: AS and PAS.

C. Construct electrically continuous piping for the process services listed above and connect directly or indirectly to earth ground.

D. Provide bonding jumpers where sections of pipe are interrupted with non-conducting sections, fully lined valves that are not through-bolted or other interruption in continuity.

E. Remove any coatings, dirt, grease or other contaminants from flanges where jumpers are to be installed. Apply sufficient conductive, anti-oxidant compound to protect the entire ferrule from galvanic action and hydrogen sulfide attack.

3.07 SEWER AND DRAIN PIPING

A. Run horizontal drainage piping as straight as practicable and at uniform pitch.

B. Install pipe 3-inch or less in diameter with slope of not less than two percent, unless otherwise specified on the Drawings.

C. Install pipe larger than 3-inch diameter with slope of not less than one percent, unless otherwise specified on the Drawings or required by the Plumbing Code.

3.08 SLEEVES

A. Unless otherwise noted in the specified pipe penetration details or otherwise approved by the Construction Manager, provide sleeves where piping passes through a wall, floor, or ceiling.

B. Locate and place sleeves prior to construction of cast-in-place elements and prior to the construction of concrete and masonry building elements.

3.09 PIPE JOINTS AND CONNECTIONS

A. Field cuts for glass-lined pipe are not permitted.

B. Cut pipe with appropriate tool and deburr.

C. Make joints tight. Test and remake leaking joints with new materials. Do not use thread cement or caulking to remake joints.

D. Do not use sharp toothed wrench in making up brass pipe, or chrome plated items.

E. Provide thread forms and length in accordance with ASME standards. Use lubricant or sealant on male threads suitable for proposed pipe service.

F. Clean joints before soldering. Use flux and alloy appropriate for specified operating temperature and pressure.

G. Welding procedures, welder certification/qualification, and weld testing per ASME Section IX, Boiler and Pressure Vessel Code. Make welds per the specified standard when ASME B31.1 or ASME B31.3 are specified for a Piping System in the Piping System Schedules (Sections 40 05 02.00 through 40 05 02.99).

H. Coat gasket with gasket manufacturer's recommended lubricant between flange faces.

3.10 TAKEDOWN COUPLINGS

A. Takedown Couplings: Provide takedown couplings at the locations specified on the Drawings in accordance with this Section.

B. Provide takedown couplings at changes in piping direction and where specified in the Drawings on straight runs of pipe.

C. Provide screw unions, flanged or grooved end coupling type joints as takedown couplings.

D. Use flanged or grooved end joints on pipelines 1.5-inch diameter and larger.

E. Where piping passes through walls provide takedown couplings within 40 inches of the wall.

F. Provide a union or flanged connection within 24 inches of each threaded end valve.

3.11 INSTALLATION OF BURIED PIPE AND PIPE BELOW STRUCTURES

A. Trenching and backfill for buried pipe: conform to Section 31 23 00.

B. Pipe laying and bedding: conform to Section 31 23 00.

C. Restrain all plugs, caps, tees and bends in buried pressure piping systems by means of restrained joints as specified in the respective Piping System Schedule.

D. In accordance with Section 40 05 06, and where specified on the Drawings, provide flexibility per specified details where buried pipe passes under, through, or is connected to structures. Provide restrained joint connections or provide restraints across each un-restrained joints.

E. Install pipe in straight alignment. Do not exceed 3/8-inch variance over 30 ft from the true alignment in any direction.

F. Slope gravity lines uniformly from point of origin to discharge.

G. Ensure the pipe alignment stays true during and after placement of concrete encasement.

H. Ensure that the method used to prevent pipe uplift during placement of concrete encasement results in an invert and crown true to intended grade.

I. Maintain circular cross section of pipe.

J. Provide lean concrete below the underside of the slab or footing for backfill over pipe laid below structures when pipe is less than 6 inches below the underside of the slab or footing, unless specified otherwise. Place concrete in accordance with Section 03 30 00.

K. Provide Heat-Shrinkable Cross-Linked Polyolefin Coating or Tape Wrap coating on all flanged, grooved, and welded joints that are buried or below structures.

L. Provide Petrolatum Tape wrap on all valves and mechanical pipe couplings that are buried or below structures. Install per manufacturer's recommendations. Candidate Manufacturers:
   1. Denso Densyl Tape
   2. #1 Wax Tape
   3. Approved Equal

M. Use anti-seize compound with all stainless steel nuts and bolts.

N. Provide detectable warning tape for all buried pipe. Provide tracer (locate) wire as specified in Section 40 05 45.

3.12 EXPOSED INSTALLATION

A. Fabricate and install domestic hot and cold water piping, sanitary piping and storm drainage piping in accordance with the Plumbing Code.

B. Provide pipe system layout in accordance with the following criteria:
   1. Drawings show general layout of piping. Exact dimensions determined by Contractor.
   2. Maintain minimum clear areas through tunnels and principal access aisles as specified in this Section.
   3. Expanding or swaging of tubing to fit IPS (Iron Pipe Size) fitting sockets is not permitted.
   4. Use reducing fittings where change in pipe size occurs.
   5. Use couplings only where pipe runs are longer than standard supplied pipe lengths.
   6. Make exposed polished or enameled connections to fixtures or equipment with special care to avoid damage to finished surfaces.
   7. Make changes in direction only with fittings.
   8. Install piping with not less than minimum slope to ensure adequate drainage and venting.
   9. Maintain clear areas around equipment to allow adequate access for maintenance as specified in this Section.
   10. Ensure valve operators are accessible from floor level. Provide chain wheel operators for valves with centerline elevations of 7 feet or above.
   11. Ensure piping ancillaries and in-pipe instrumentation is installed in accessible locations which do not create problems for traffic in the clear areas.

C. Make adequate provision in piping and pipe support systems for expansion, contraction, slope, and anchorage.

D. Install pipe support system to adequately secure the pipe and to prevent undue vibration, sag or stress.

E. Install expansion joints where specified on the Drawings or where required by the Design Professional, to allow for piping expansion and contraction.

F. Install expansion loops or bends where specified, or required by the Design Professional, to allow for proper pipe expansion. Construct expansion loops with long radius welded bends.

G. Provide temporary supports as necessary during construction to prevent overstressing of equipment, valves or pipe.

H. Accurately cut all piping for fabrication to field measurements.

I. Install pipes in straight alignment and parallel to wall. Do not exceed 3/8-in variance over 30 ft from the true alignment, in any direction.

J. Fabricate and assemble pipe runs so that the pipework is not stressed to achieve the desired alignment and that no stresses are transferred to equipment or equipment flanges. Unless stipulated by the Design Professional to address significant thermal strain, and accepted by the Construction Manager, the "springing" of pipe and fittings to ensure alignment is not permitted. Undo and subsequently remake all pipework connections where so instructed by the Construction Manager to ensure that unintended springing does not occur. Take care not to damage equipment, valves, or flanges.

K. Slope instrument air piping to condensate traps.

L. Do not cut or weaken the building structure to facilitate installation of piping.

M. In parallel pipe runs, offset flanges and/or grooved joint fittings by a minimum of 8 inches longitudinally to allow for proper access.

N. In vertical pipe runs of pipe diameter greater than 10 inches, provide 8-inch long spool piece on lower side of each valve.

O. Do not install water piping over electric switchboards, transformers, cable tray or electric motor starters.

P. Provide pipe markers for all exposed pipe.

3.13 THREADED JOINTS

A. Conform to the requirement of ANSI B31.1.

B. Ream the end of all pipes to remove all burrs and cuttings when fabricating threaded joints.

C. Clean out pipe and repair linings and coatings prior to joining.

D. Apply Teflon tape to male threads and join pipe. Use both Teflon tape and Teflon sealing compound on stainless steel pipe threads. Do not apply extra tape to make up for slack in the joint.

3.14 FLANGED JOINTS

A. Maintain consistent flange bolt hole positions along the entire length or run of the pipe.

B. For pipe installed with a horizontal axis, position flange bolt holes so that the vertical centerline of the flange face bisects the arc between flange bolt holes (“Two-Holed”).

C. For pipe installed with a vertical axis, position flange bolt holes so that the horizontal centerline of the flange face bisects the arc between flange bolt holes and is perpendicular to the closest structural wall (“Two-Holed”).

D. Clean flanges and gaskets prior to connection.

E. Lubricate gaskets with gasket manufacturer’s recommended lubricant and apply anti-seize compound to all bolts.

F. Bring flanges into close parallel and lateral alignment.

G. Tighten bolts progressively. Proceed from side to side of the flange.

H. Use proper length bolts for each size flange on flanged connections. Washers may not be used to take up excess bolt length. Provide approximately two full threads bolt projection beyond nuts. Bolts with excessive length of exposed threads will not be permitted. All-thread rod is not acceptable for bolting flanges.

I. When joining steel to cast iron flanges, take care to avoid damage to the cast iron flange. Ensure both flanges are flat-faced and use full face gaskets.

J. Align flanges which connect piping to mechanical equipment to close parallel and lateral alignment prior to tightening bolts. Do not place strain on the equipment.

K. Allow a minimum of 6 inches’ clearance to face or 8 inches to edge of flange to wall, floor, or ceiling unless otherwise specified.

3.15 INSULATION

A. Insulate piping systems in accordance with the Piping System Schedules (Sections 40 05 02.00 through 40 05 02.99) and Section 40 42 00.

3.16 FLEXIBLE HOSE CONNECTORS

A. Accurately align pipelines to receive flexible connectors before installing the connectors. Do not stretch, compress, misalign or offset the connectors.

B. Align and install each flexible connector in accordance with the manufacturer's instructions.

C. Support, anchor and guide the piping so that the flexible hose connectors are not required to absorb any axial compression or elongation.

D. Do not torque or twist the flexible connectors.

E. Check bolt tightness and tighten where necessary, a maximum of one week after commissioning and periodically thereafter.

3.17 EXPANSION JOINTS

A. Accurately align pipelines to receive expansion joints before installing the joint. Do not stretch, compress or offset the joint to fit the piping. Install expansion joints in accordance with manufacturer's instructions prior to releasing preload.

B. Align and install each expansion joint in accordance with EJMA standards and with the manufacturer's written instruction; properly guide and anchor all expansion joints. No lateral movement is permitted on compensator type expansion joints.

C. On rubber expansion joints, check bolt tightness, and tighten where necessary one week after Commissioning is completed.

3.18 REPAIR/RESTORATION

A. Repair pipe with damaged shop-applied protective linings in accordance in accordance with specified standard (e.g. AWWA C210) or accordance with the lining manufacturer's directions, if no standard is cited.

B. Damaged glass lining cannot be repaired. Replace piping with damaged glass lining.

C. Patching inserts, overlays, or pounding out of dents is not be permitted.

D. Repair pipe with damaged protective coatings and holdback areas for welding and other field fabrication, as follows:
   1. For shop-applied coatings, not subject to Section 09 90 00 requirements, in accordance with specified standard (e.g. AWWA C210) or in accordance with the coating manufacturer's directions, if no standard is cited.
   2. For coatings applied pursuant to Section 09 90 00 requirements, apply repair coatings in conformance with the applicable Section 09 90 00 coating system, including thickness and stipulated preparation of the lowest full thickness coating layer (i.e. exposed metal would require full profile preparation and specified multi-layer coating restoration).
   3. Prepare areas to be repaired not less than 2-inches beyond damaged areas and feather repair coating into adjacent areas.
   4. Repair to provide equivalent protection to undamaged coatings and a uniform appearance when judged from 4 feet away.

E. Other requirements may be stipulated in related piping sections.

3.19 FIELD QUALITY CONTROL

A. Inspections:
   1. Inspect and provide reports as specified in Section 40 05 07, Section 40 05 07.13, and Section 40 05 07.16.
   2. Submit the Design Professional's final report before beneficial occupancy by the Owner.

3.20 TESTING

A. Provide 24 hours notice prior to testing.

B. Do not insulate or conceal work until piping systems are tested and have met all required criteria.

C. Complete any required weld tests.

D. Supply all water, air, and inert gases required for pressure testing.

E. Supply all pumps, compressors, gauges, etc. required for testing.

F. Install air threadolets, air relief valves, and line fitting valves as necessary to complete testing. Remove after testing and plug threadolets.

G. Cap or plug all lines which are normally open ended. Remove on completion of testing.

H. Provide all temporary thrust restraints necessary for testing. Remove upon completion of testing.

I. Test all underground lines prior to backfilling. Do not place concrete encasement until lines are tested and have met all required criteria.

J. Test all existing piping where it connects to new piping to the first valve in the existing piping. Repair any failures in existing piping which occur as a result of the test after informing the Construction Manager of such failure.

K. Isolate all pumps and low pressure equipment and appurtenances during testing so as not to place any excess pressure or thrust forces on the equipment.

L. Where defective material or equipment is identified, repair or replace using new material.

M. Flush and drain liquid pipes after pressure tests. Purge all gas pipes after pressure tests using inert gas.

N. Dispose of flushing water in manner approved by the Construction Manager, which causes no damage to buildings or siteworks.

3.21 HYDROSTATIC PRESSURE TESTING OF LIQUID LINES

A. Hydrostatically test all lines normally used for the conveyance of liquids using water as the test medium, unless otherwise specified in this Section.

B. Test pressures and durations as specified in the Piping System Schedules.

C. Ensure all lines are filled with water. Bleed air from all high spots using the taps provided specifically for that purpose.

D. Lined pipelines: Allow filled pipeline or section thereof to stand under a slight pressure for at least 8 hours (24 hours for cement mortar lining) to allow the lining to absorb water and to allow the escape of air from air pockets.

E. Zero leakage is permitted throughout the specified test period for all exposed piping, buried insulated piping, and any liquid chemical lines.

F. Show evidence of leakage rates below 0.02 gal per hour per inch pipe diameter per 100 ft of pipe length for buried piping, unless otherwise specified.

G. Test drains in accordance with the Plumbing Code.

H. For hydraulic and lube oil systems, test using the medium of service. Provide zero loss of pressure throughout the specified test period.

3.22 PNEUMATIC PRESSURE TESTING

A. Use nitrogen gas or oil free dry air to test piping systems where nitrogen or air is the specified testing medium in the Piping System Schedule.

B. Submit a testing plan and a safety plan for each piping system that will be pressure tested with nitrogen gas or oil free dry air. Do not perform pressure testing with air or nitrogen until a favorable review of the safety plan and testing plan for the piping system has been returned from the Construction Manager. Comply with all workplace safety and pressure vessel safety codes and guidelines.

C. Provide a separate pressure relief valve for pneumatic pressure testing.

D. Locate pressure relief valve within visual range of the test gauge and with exhaust to a safe location.

E. Set relief valve at not more than full test pressure plus 10 percent.

F. Continuously monitor and control testing to assure personnel safety and piping integrity.

G. Remove all personnel from areas where piping will be subjected to pressure tests and prevent entry into testing areas until test pressure has been relieved.

H. Protect installed work from potential damage from pressure testing failures. The Contractor is responsible for any damage or injury resulting from failed pressure testing with air or nitrogen.

I. When using nitrogen or air to test steel or stainless steel pipelines, gradually introduce the test gas up to a pressure of 45 psig or 1/3 of specified test pressure, whichever is less.

J. While maintaining this pressure, test lines for leaks using soapy water.

K. When the line is free from leaks at this pressure, increase by increments of 50 psig or 1/3 of specified test pressure (whichever is less) to the specified test pressure.

L. After each increment, retest using soapy water; take corrective action as necessary.

M. When the system is free from leaks at the test pressure, depressurize the system slowly.

N. To prevent the entrance of water or moisture into the medium source, disconnect the test source from the system and cap.

O. Where specified, maintain nitrogen pad after testing until the line is put into service. Label any piping for which a pad is provided and maintained.

P. Provide high purity nitrogen gas used for testing, in cylinders fitted with pressure regulators for 0 to 300 psig and all necessary fittings and adaptors necessary to complete the connection between the source and the system header. Provide self-relieving type pressure regulator that vents to the atmosphere and include a throttling valve.

Q. Provide oil free air with a relative humidity of zero for testing. Provide all fittings, adaptors, accessories, and the pressure regulator and throttling valve that are suitable for pressure testing with air and rated for 300 psig service.

3.23 PRESSURE TESTING OF GAS, AIR, AND VAPOR LINES

A. Hydrostatically or pneumatically pressure test, as specified in the Piping System Schedules, all lines normally used for the conveyance of gas, air, and/or vapor in accordance with ASME procedures for testing pressure piping and CAN/CGA B149.6 for buried digester gas piping. Pneumatically test all instrument air lines in accordance with ISA-S7.0.01 and digester gas piping in accordance with CAN/CGA B149.6.

B. For gas and air lines to be hydrostatically tested, check support system to ensure it is capable of withstanding loads imparted by test method. Provide any additional supports necessary in a manner acceptable to the Construction Manager. At the Construction Manager's request, provide calculations indicating design of temporary support system.

C. Test pressures are identified in the Piping System Schedule.

D. Zero leakage rate is required at the specified test pressure through the test period. Prior to commencing test using air, ensure air will be at ambient temperature and specified test pressure.

E. Do not exceed the maximum specified leakage rate during the test period for all other systems tested with air.

F. Remake all joints which display leakage and retest.

3.24 TESTING OF HAZARDOUS GAS AND LIQUID LINES

A. The following process pipes shall be tested as Hazardous Gas or Liquid lines: BWC, CAS, CLG, CLS, SAS, SB, SHC, and SHX.

B. Remove components which may be damaged by test pressures and plug openings. Provide tee in any existing lines to be tested adjacent to the terminal valve.

C. Pressure test after cleaning.

D. Zero leakage at specified test conditions is required. Repair and retest lines until successful test is achieved. Test all digester gas lines in accordance with CAN/CGA B149.6.

E. Plug and/or disconnect all vents to the atmosphere, close all valves to the atmosphere, and open all in-line valves. Return the system to its appropriate operating condition after testing, including resetting of vents and valves.

F. Hydrostatically test PVC and CPVC pipelines using water as the test medium, as specified in the Piping System Schedules. Where support systems are not designed for hydrostatic testing or drying of steel pipelines is impractical, with the Construction Manager's approval, the Contractor may use nitrogen gas or dry air as the test medium, providing the specified safety plan is submitted and necessary safety precautions are implemented to minimize the risk incurred when performing such a test.

G. Replace all moisture absorbing gaskets and valve packing after hydrostatic testing.

H. After testing, dry all lines.
   1. Steel or stainless steel Lines: Pass steam through the lines from the high end until all lines are thoroughly heated. Allow condensate and foreign material to drain during steaming. Disconnect and drain lines from all low points. While lines are warm, blow dry, oil-free air with a dew point below -40 degrees F through the system until the existing dew point is the same as the supply air. Fix valves in the half open position during drying. Ensure that valves temporarily removed from the system during drying operations are completely free of moisture prior to reinstallation.
   2. PVC Lines: Drying applies solely to vacuum lines. Drain and remove all free water and moisture from the system. Swab the pipe to remove any excess water. Air dry the pipe in the same manner as steel lines, additionally ensuring that the entering air temperature is not greater than 120 degrees F.

I. Fill the line with inert gas if service gas is reactive with air.

J. Introduce service gas immediately after testing and drying and inert gas filling. Test the system for leaks. Allow time for the complete replacement of air or inert gas from the piping with the service gas.

K. Use an appropriate sensing device when testing for leaks.

L. If leaks are detected when the system is tested with service gas, do not implement repairs until all gas has been purged from the system. Repeat the hydrostatic testing and drying sequence prior to retesting the line with service gas.

3.25 CLEANING AND FLUSHING

A. After installation and prior to testing, perform initial cleaning of process and utility lines. Clean piping greater than 6 inches and less than 24 inches by passing a tightly fitting cleaning ball or swab through the pipeline, unless specified otherwise. Lines greater than 24 inches may be cleaned manually or with a cleaning ball or swab. Give lines smaller or equal to 6 inches an initial flush or purge.

B. After initial cleaning, connect the piping systems to related process and mechanical equipment. Insert temporary screens, provided with visible locator tabs, in the suction of pumps and compressors in accordance with the following table:

Suction size, in.	Maximum screen opening, in.
0 – 1	1/16
1-1/4 – 3	1/4
3-1/2 – 6	1/2
Over 6	1

C. Maintain the screens during testing, flushing/purging, initial startup, and the initial operating phases of the commissioning process. In special cases and with the Construction Manager's acceptance, screens may be removed for performance tests. Install screens for clear water testing and initial operation on liquid systems handling solids. Initial operation on solids systems following clear water testing may be without screens.

D. Unless specified otherwise, flush liquid systems after testing, with clean water and screens in place. Maintain flushing for a minimum period of 15 minutes and until no debris is collected in the screens.

E. Remove the screens and make the final connections after the screens have remained clean for a minimum of 24 consecutive hours of operation. Keep screens in place for 24 hours of clean water operation on solids handling systems; remove prior to placing the system into solids handling service.

F. In air or gas systems with pipe sizes less than or equal to 6 inches, purge with air and/or inert gases before testing. Upon completion of testing and cleaning, drain and dry the piping with a dry air stream. Satisfy ANSI/ISA-S7.0.01 standards for instrument air systems.

G. Purge digester gas, natural gas, and propane systems with nitrogen gas and provide a nitrogen pad maintained at 10 psig until put in service. Purge and dry digester gas systems in accordance with CGA B149.6.

H. For hazardous gas and liquid systems, clean interior of the pipelines by drawing a cloth or swab impregnated with an appropriate solvent (carbon tetrachloride or trichloroethylene) through the pipe. Do not clean interior of refrigerant lines. Dismantle valves and hand clean. Plug lines at the end of each day. Properly dispose of all waste solvents.

I. Clean and flush piping connecting to HVAC equipment in accordance with Division 23.

3.26 DISINFECTION

A. Flush and disinfect lines intended for potable water service after testing in accordance with AWWA C651 and Section 01 74 10.

END OF SECTION

SECTION 40 05 02

PIPING SYSTEM SCHEDULES

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies a Piping System Schedule for each Process Service. Each Piping System Schedule specifies piping system materials for groups of similar process piping services.

B. The table in paragraph 1.01C lists process services and the corresponding Piping System Schedule that specifies piping system material requirements for the associated process piping service. See Part 4 for Piping System Schedules that define materials for piping services.

C. Piping System Schedule assignments are listed in the following table:

Process Service Identifier	Process Service	Area Exposure Type	Piping System Schedule	Fluid Category	Color
AS	Air Scour	IE	40 05 02.01	Compressed Air	Dark Grey
		IB	40 05 02.01		
BWC	Backwash Coagulant	IE	40 05 02.54	Toxic/Corrosive	Orange
			40 05 02.65		
		IB	40 05 02.54		
			40 05 02.65		
		OE	40 05 02.54		
			40 05 02.65		
		OB	40 05 02.54		
			See C-00-401		
CAS	Citric Acid Solution	IE	40 05 02.54	Toxic/Corrosive	Orange
			40 05 02.65		
CBS	Chlorine Booster System	IE	40 05 02.65	Toxic/Corrosive	Orange
		IB	40 05 02.65		
CBW	Chemical Backwash Water	IE	40 05 02.65	Toxic/Corrosive	Orange
		IB	40 05 02.19		
		OB	40 05 02.13		
CLG	Chlorine Gas	IE	40 05 02.65	Toxic/Corrosive	Orange
CLS	Chlorine Solution	IE	40 05 02.54	Toxic/Corrosive	Orange
			40 05 02.65	Toxic/Corrosive	Orange
		IB	40 05 02.65	Toxic/Corrosive	Orange
D	Drain	IE	40 05 02.65	Multiple	Green
		IB	40 05 02.19		
		OB	40 05 02.13		
		TS	40 05 02.03		
FW	Finished Water	IE	40 05 02.03	Water	Blue
		IB	40 05 02.19		
		OB	40 05 02.13		
		TS	40 05 02.03		
GBW	GAC Backwash Water	IE	40 05 02.03	Water	Blue
		IB	40 05 02.19		
GEC	GAC Effluent (Complete)	IE	40 05 02.03	Water	Blue
		IB	40 05 02.19		
		OB	40 05 02.13		
		TS	40 05 02.03		

Process Service Identifier	Process Service	Area Exposure Type	Piping System Schedule	Fluid Category	Color
GEI	GAC Effluent (Interstage)	IE	40 05 02.03	Water	Blue
MBW	Membrane Backwash Water	IE	40 05 02.01	Water	Blue
		IB	40 05 02.19		
MCH	Membrane CIP Heating	IE	40 05 02.01	Toxic/Corrosive	Orange
MCR	Membrane CIP Recirculation	IE	40 05 02.65	Toxic/Corrosive	Orange
		IB	40 05 02.19		
MCW	Membrane CIP Waste	IE	40 05 62.65	Toxic/Corrosive	Orange
		IB	40 05 02.19		
MFE	Membrane Filtration Effluent	IE	40 05 02.01	Water	Blue
		IB	40 05 02.19		
MIT	Membrane Integrity Test	IE	40 05 02.01	Compressed Air	Dark Grey
		IB	40 05 02.01		
OF	Overflow	IE	40 05 02.65	Multiple	Black
		OE	40 05 02.03		
PAS	Plant Air System	IE	40 05 02.01	Compressed Air	Dark Grey
		IB	40 05 02.01		
PW	Potable Water	IE	40 05 02.65	Water	Blue
		IB	40 05 02.19		
		OB	40 05 02.13		
RBW	Recycled Backwash Water	OE	40 05 02.03		
		OB	40 05 02.13	Water	Green
		TS	40 05 02.03		
RW	Raw Water	IE	40 05 02.03	Water	Blue
		IB	40 05 02.19		
		OB	40 05 02.13		
SA	Sample	IE	40 05 02.06	Water	Blue
SAS	Sulfuric Acid	IE	40 05 02.54	Toxic/Corrosive	Orange
			40 05 02.65		
SB	Sodium Bisulfite	IE	40 05 02.54	Toxic/Corrosive	Orange
			40 05 02.65		
SBS	Settled Backwash Solids	OE	40 05 02.03	Water	Green
		OB	40 05 02.13		
		TS	40 05 02.03		
SBW	Settled Backwash Water	OE	40 05 02.03	Water	Green
		OB	40 05 02.13		
		TS	40 05 02.03		
SHC	Sodium Hypochlorite	IE	40 05 02.54	Toxic/Corrosive	Orange
			40 05 02.65		
		IB	40 05 02.54		
			40 05 02.65		
SHX	Sodium Hydroxide	IE	40 05 02.54	Toxic/Corrosive	Orange
			40 05 02.65		
UW	Utility Water	IE	40 05 02.65	Water	Blue
V	Vent	IE	40 05 02.65	Vent	Black
		OE	40 05 02.03		
WBW	Waste Backwash Water	IE	40 05 02.65	Water	Green
		IB	40 05 02.19		
		OE	40 05 02.03		
		OB	40 05 02.13		
		TS	40 05 02.03		

Note: See Sheets C-00-401 and P-00-001 in the Drawing Package and Sections 22 and 33 of the Specifications for piping labeled with the following identifiers: CD, CW, HW, and SD, SS.

Area Exposure Types		Description	Area [1]						
			00	10	2X	30	40	50	70
IE	Indoor - Exposed	Above Grade			●				
IB	Indoor – Buried [2]	Below Grade |Under Slab			●				
OE	Outdoor - Exposed	Above Grade | Dry Vaults/Channels	●	●		●			●
OB	Outdoor - Buried	Below Grade	●	●		●	●	●	●
TS	Tank - Submerged	Inside Tanks |Wet Vaults/Channels		●		●	●		●

[1] See drawing I-00-004 for area code designations. Area 2X includes Area 20 through 27. Area 00 includes all general and undefined areas.

[2] Area Exposure Type IB extends approximately five feet into the yard outside of the building foundation.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

Reference	Title
ASME B1.20.1	Pipe Threads, General Purpose
ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, and 250
ASME B16.3	Malleable Iron Threaded Fittings Class 150 and 300
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B16.9	Factory-Made Wrought Steel Butt Welding Fittings
ASME B16.11	Forged Steel Fittings, Socket Welding and Threaded
ASME B16.12	Cast Iron Threaded Drainage Fittings
ASME B16.18	Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B31.1	Power Piping
ASME B31.3	Process Piping
ASME B31.9	Building Services Piping
ASME B32	Solder Metal
ASME B36.10	Welded and Seamless Wrought Steel Pipe
ASME B36.19	Stainless Steel Pipe
ASME B1.1	Unified Inch Screw Threads
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Requirements
ASTM A47	Malleable Iron Castings
ASTM A53	Pipe, Steel, Black and Hot Dipped, Zinc Coated Welded and Seamless
ASTM A74	Cast Iron Soil Pipe and Fittings
ASTM A105/A105M	Forgings, Carbon Steel, for Piping Components
ASTM A106	Seamless Carbon Steel Pipe for High Temperature Service
ASTM A126	Grey-Iron Castings for Valves, Flanges, and Pipe Fittings

Reference	Title
ASTM A135	Electric-Resistance-Welded Steel Pipe
ASTM A139	Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and Over)
ASTM A167	Stainless Steel and Heat-Resisting Chromium-Nickel Steel Plate
ASTM A181/181M	Forgings, Carbon Steel, for General Purpose Piping
ASTM A182/182M	Forged or Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193/193M	Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service High Pressure Service and Other Special Purpose Applications
ASTM A194/194M	Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service or High Temperature Service, or Both
ASTM A197	Cupola Malleable Iron
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A240	Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels
ASTM A269	Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A307	Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength
ASTM A312/312M	Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A320/320M	Alloy Steel Bolting Materials for Low-Temperature Service
ASTM A403/A403M	Wrought Austenitic Stainless Steel Piping Fittings
ASTM A409/A409M	Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service
ASTM A480/A480M	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A480/A480M	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A536	Ductile Iron Castings
ASTM A563	Carbon and Alloy Steel Nuts
ASTM A774/A774M	As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
ASTM A778	Welded, Unannealed Austenitic Stainless Steel Tubular Products
ASTM A1011/A1011M	Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High- Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B75	Seamless Copper Tube
ASTM B88	Seamless Copper Water Tube
ASTM B584	Copper Alloy Sand Castings for General Applications
ASTM C76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C361	Reinforced Concrete Low-Head Pressure Pipe
ASTM C443	Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C478	Circular Precast Reinforced Concrete Manhole Sections
ASTM D638	Test Method for Tensile Properties of Plastics
ASTM D792	Test Method for Specific Gravity and Density of Plastics by Displacement
ASTM D1248	Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl

Reference	Title
	Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
ASTM D2466	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2513	Thermoplastic Gas Pressure Pipe, Tubing, and Fittings
ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D2996	Filament-Wound Reinforced Thermosetting Resin Pipe
ASTM D3034	Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals
ASTM D3261	Butt Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Fittings
ASTM D3350	Polyethylene Plastics Pipe and Fittings Materials
ASTM D4101	Propylene Plastic Injection and Extrusion Materials
ASTM D4174	Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems
ASTM D4894	Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials
ASTM D4895	Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced from Dispersion
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F894	Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
AWWA C104	Cement–Mortar Lining for Ductile-Iron Pipe and Fittings
AWWA C105	Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
AWWA C110	Ductile-Iron and Grey-Iron Fittings, 3 Inch Through 48 Inch, for Water and Other Liquids
AWWA C111	Rubber-Gasket Joints for Ductile-Iron and Grey-Iron Pipe and Fittings
AWWA C115	Flanged Ductile-Iron and Grey-Iron Pipe with Threaded Flanges
AWWA C150	Thickness Design of Ductile-Iron Pipe
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water and Other Liquids
AWWA C153	Ductile-Iron Compact Fittings
AWWA C200	Steel Water Pipe, 6 Inches and Larger
AWWA C203	Coal Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied
AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 Inches through 144 Inches
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Services - Sizes 4 Inch Through 144 Inch
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold-Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Coal-Tar Epoxy Coating System for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines

Reference	Title
AWWA C222	Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings
AWWA C301	Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
AWWA C303	Reinforced Concrete Pressure Pipe - Steel Cylinder Type, Pretensioned, for Water and Other Liquids
AWWA C600	Installation of Ductile-Iron Water Mains and their Appurtenances
AWWA C606	Grooved and Shouldered Joints
AWWA C651	Disinfecting Water Mains
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water
AWWA M11	Steel Pipe - A Guide for Design and Installation
CISPI 301	Specification Data for Hubless Cast Iron Sanitary System with No-Hub Pipe and Fittings
EJMA STDS	Standards of Expansion Joint Manufacturers' Association, Edition No. 6
FSA	Fluid Sealing Association Technical Handbook, Rubber Expansion Joint Division
FEDSPEC, L-C-530B(1)	Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy
IPC	International Plumbing Code 2021 with Local AHJ Amendments
MIL-H-13528B	Hydrochloric Acid, Inhibited, Rust Removing
MIL-S-8660C	Silicone Compound
MIL-STD-810C	Environmental Test Methods
MSS SP-25	Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-43	Wrought Stainless Steel Butt Welding Fittings
MSS SP-97	Integrally Reinforced Forged Branch Outlet Fittings – Socket Welding, Threaded, and Buttwelding Ends
MSS SP-114	Corrosion Resistant Pipe Fittings Threaded and Socket Welding Class 150 and 1000
NSF/ANSI 61:	Drinking Water System Components – Health Effects
SSPC	Society for Protective Coatings
SAE J1227	Assessing Cleanliness of Hydraulic Fluid Power Components and Systems

1.03 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:

B. Pipe Connections and Joints:
   1. BABS – Bell and Ball Spigot
   2. BAS – Bell and Spigot
   3. BFW – Butt Fusion Weld
   4. BSS – Bolted Split Sleeve Coupling
   5. BW – Butt Weld
   6. BSW – Butt-Strap Weld
   7. CGRV – Cut (or Cast) Grooved End Coupling
   8. CPLG – Coupling
   9. CPO – Compression Type Push-On
   10. CPRSN – Compression

11. DLW – Double Lap Weld (Bell and Spigot)
12. EFSW - Electro-Fusion Socket Weld
13. FLG – Flanged
14. FLRD – Flared
15. FP – Full Penetration
16. FSW – Fusion Socket Weld
17. HAS – Hub and Spigot, Compression (Cast Iron Soil Pipe)
18. HBLS - Shielded Hubless (Cast Iron Soil Pipe)
19. HGRV – HDPE Groove Coupling
20. HLF CPLG – Half Coupling
21. HPEG – HDPE Plain End with Gripping Teeth
22. HXGT - HDPE by Grooved End Transition
23. LR ELL – Long Radius Elbow
24. MJ – Mechanical Joint
25. PGRV - Proprietary Groove Coupling
26. PO – Push-on
27. RBAS – Restrained (Lap Welded) Bell and Spigot with O-ring rubber gasket
28. RGRV – Rolled Grooved End Coupling
29. RJC – Ring Joint Coupling
30. RMJ – Restrained Mechanical Joint
31. RPO – Restrained Push-On joint
32. SLV – Solvent Weld
33. SLDR – Solder or Brazing
34. SLW – Single Lap Weld (Bell and Spigot)
35. SR ELL – Short Radius Elbow
36. SW – Socket Weld
37. THD – Threaded
38. UN – Union

C. Flanges:
   1. FF – Full Face
   2. LF – Loose Flange
   3. LJ – Lap Joint
   4. LWN – Long Weld Neck
   5. RF – Raised Face
   6. SO – Slip-On
   7. THD – Threaded
   8. WN – Weld Neck

D. Materials:
   1. DI – Ductile Iron
   2. RCP – Reinforced Concrete Pipe

3. RCP-LHP – Reinforced Concrete Low Head Pressure Pipe
4. SS – Stainless Steel
5. SV – Service (Cast Iron Soil Pipe available with SV rating or XH, extra heavy, rating)

E. Welding:
1. FP – Full Penetration
2. SML – Seamless
3. WLD – Welded

F. Other:
1. CFT - Cured Film Thickness
2. DFT – Dry Film Thickness
3. Dim – Dimensions
4. M or E Pipe – Matches or exceeds rating of connecting pipe
5. Thk – Thickness
6. Sch – Schedule
7. Std – Standard
8. STD – Standard Weight or Standard

PART 2 PRODUCTS

2.01 MATERIALS

A. Pipe size (nominal diameter) and the Process Service Identifier for the contents of the pipeline are specified in pipe line labels on the drawings.

B. Provide piping system materials and components per the Piping System Schedule assigned for the specified process service and pipe size.

C. The Rating column in the Piping System Schedule specifies the minimum acceptable pressure rating or wall thickness for the component of the piping system.

PART 3 NOT USED

PART 4 SCHEDULES

4.01 PIPESPEC SYSTEM SHEETS/DETAILED PIPING SPECIFICATION SHEETS.

A. Piping System Schedules follow this Section. Piping System Schedules are assigned a Section number in the range from 40 05 02.00 through 40 05 02.99.

END OF SECTION

SECTION 40 05 02.01

STAINLESS STEEL PIPE PIPE SCHEDULE

Process Service Identifier	AS	MBW	MCH	MFE
Process Service	Air Scour	Membrane Backwash Water	Membrane CIP Heating	Membrane Filtration Effluent

Area Exposure Types | Design Requirements | Testing Requirements

Process Service Identifier	Indoor Exposed (IE)	Indoor Buried (IB)	Design Pressure (psig)	Design Temperature (°F)	Test Pressure (psig)	Test Duration (min)	Test Medium
AS	●	●	40	180	60	120	Air
MBW	●		100	120	150	120	Water
MCH	●		100	180	150	120	Water
MFE	●		100	120	150	120	Water

General Requirements

A. Comply with the provisions of Section 40 05 01 in addition to the requirements specified herein. Refer to Section 40 05 02 for definitions of abbreviations and acronyms used in this schedule.

B. All piping shall be designed, fabricated and inspected in accordance with ASME B31.3.

C. Welding shall be in accordance with Section 40 05 23.

D. Full-Faced flanges mated with raised face flanges are not permitted.

E. Mating flanges for pipe shall be of the same Standard, Class and Series. Mating flanges at valves and equipment shall have specified rating and matching pattern.

F. Pipe threads per ASME B1.20.1.

G. Match metal alloy/grade/type for any metal welded to pipe or fittings. (e.g. Do not weld carbon steel to stainless steel; weld Type 316L to Type 316L pipe material.)

H. All materials shall be certified for use in a potable water system (ANSI/NSF 61) and shall meet the requirements specified therein.

Key Notes

1. Flange bolt length per ASME B16.5 plus three additional threads. Hex head bolt dimensions per ASME B18.2.1. Class 2A standard coarse series threads per ASME B1.1, standard coarse thread series. Hex nut dimensions per ASME B18.2.2 (Heavy Hex). Class 2B standard coarse series threads per ASME B1.1.
2. Apply Anti-seize to stainless steel bolts before turning nut on flange bolts.
3. Provide Long Radius Elbows. Provide full flow fittings. Segmentally welded fittings are not acceptable.
4. Stainless steel stub end for use with Lap Joint flanges. Stub end dimensions and materials to match pipe. Fillet radius of stub ends compatible with inner corner radius of backing flange bore.
5. Factory coat carbon steel/ductile iron backing ring flanges with Liquid Epoxy per AWWA C210, 16 mils DFT, minimum.

Process Service Identifier	AS	MBW	MCH	MFE
Process Service	Air Scour	Membrane Backwash Water	Membrane CIP Heating	Membrane Filtration Effluent

6. Provide stainless steel flange bolts, nuts, and washers with stainless steel flanges.
7. Provide weld neck flanges on both sides of wafer, lug body, and flanged valves ½ thru 12 inch.

Process Service Identifier	AS	MBW	MCH	MFE
Process Service	Air Scour	Membrane Backwash Water	Membrane CIP Heating	Membrane Filtration Effluent

Area Exposure Types: Indoor– Exposed [IE]

Component	Line Size, in	Material	Rating	Conn./Joints	Spec Section	Key Notes
Pipe	1/8 thru 2-1/2	Stainless Steel: ASTM A312-TP316L, SML, Dim. Per ASME B36.19	Sch. 40S	BW, SW, THD, FLG	40 05 23	
	3 thru 12	Stainless Steel: ASTM A312-TP316L, SML, Dim. Per ASME B36.19	Sch. 10S	BW, FLG	40 05 23	
Lining for Pipe & Fittings	All	None	—	—	—	
External Coating	Pipe and Fittings	None	—	—	—	5
	Valves	Manufacturer's Standard Primer or Primer and Finish Coating: Shop or Factory Applied	—	—	—	
Fittings	1/8 thru 2-1/2	Forged Stainless Steel: ASTM A182-F316L, Dim. per ASME B16.11	Class 3000	SW, THD	40 05 23	
		Wrought Stainless Steel: ASTM A403-WP316L, Dim. per ASME B16.9	Sch. 40S	BW, FLG		
	3 thru 12	Wrought Stainless Steel: ASTM A403-WP316L, Dim. per ASME B16.9	Sch. 10S	BW, FLG	40 05 23	3
Taps	1/8 thru 2-1/2	Forged Stainless Steel Tee: ASTM A182-F316L, Dim. per ASME B16.11	Class 3000	THD, SW	40 05 23	
		Wrought Stainless Steel Tee: ASTM A403-WP316L, Dim. per ASME B16.9	Sch. 40S	BW	40 05 23	
	3 thru 12	Forged Stainless Steel Half Coupling: ASTM A182-F316L, Dim. per ASME B16.11	Class 3000	FP Beveled Fillet Weld	40 05 23	
		Forged Stainless Steel Olet: ASTM A182-F316L, Dim. per MSS SP-97	Class 3000	FP Beveled Fillet Weld	40 05 23	
Grooved Coupling	All	None	—	—	—	
Flanges	1/2 thru 2-1/2	Forged Stainless Steel: ASTM A182-F316L, FF, Dim. per ASME B16.5	Class 150	WN, SO, THD	40 05 23	6
	3 thru 12	Plate Steel Backing Ring: ASTM A36, bolt pattern per ASME B16.5 with ASTM A403-WP316L stub end, Dim. per ASME B16.9	Class 150	LJ, LF	40 05 23	4, 5
		Welded Forged Stainless Steel: ASTM A182-F316L, FF, Dim. per ASME B16.5	Class 150	WN, SO	40 05 23	6
		Welded Fabricated Stainless Steel: ASTM A240-316L, FF, Dim. per AWWA C228	Class SD	SO	40 05 23	6
FLG Bolts, nuts and hardware	All	Stainless Steel Bolts: ASTM A193 Gr B8M Stainless Steel Nuts: ASTM A194 Gr 8M				1, 2, 6
Flange gaskets	All	Viton/FKM, PTFE	1/8 in Thk.	FLG	40 05 01	
Mechanical Coupling Gaskets	All	None	—	—	—	
Compression and Push-On Gaskets	All	None	—	—	—	

Process Service Identifier	AS	MBW	MCH	MFE
Process Service	Air Scour	Membrane Backwash Water	Membrane CIP Heating	Membrane Filtration Effluent

Area Exposure Types: Indoor– Exposed [IE]

Component	Line Size, in	Material	Rating	Conn./Joints	Spec Section	Key Notes
Valves	1/4 thru 1 1/2	Ball: Stainless Steel (316) Body/Ball	—	THD	40 05 60	
		Check: Stainless Steel (316) Silent Check	—	THD	40 05 23	
	2 thru 12	See Valve Lists on Drawing G-00-006	—	FLG	—	7
Insulation	All	None	—	—	—	

Area Exposure Types: Indoor - Buried [Includes Encased and Embeded] [IB]

Component	Line Size, in	Material	Rating	Conn./Joints	Spec Section	Key Notes
Pipe	1/8 thru 2-1/2	Stainless Steel: ASTM A312-TP316L, SML, Dim. Per ASME B36.19	Sch. 40S	BW, SW	40 05 23	
	3 thru 12	Stainless Steel: ASTM A312-TP316L, SML, Dim. Per ASME B36.19	Sch. 10S	BW	40 05 23	
Lining for Pipe & Fittings	All	None	—	—	—	
External Coating	Pipe and Fittings	None	—	—	—	5
	Valves	No Buried Valves	—	—	—	
Fittings	1/8 thru 2-1/2	Forged Stainless Steel: ASTM A182-F316L, Dim. per ASME B16.11	Class 3000	SW	40 05 23	
		Wrought Stainless Steel: ASTM A403-WP316L, Dim. per ASME B16.9	Sch. 40S	BW		
	3 to 12	Wrought Stainless Steel: ASTM A403-WP316L, Dim. per ASME B16.9	Sch. 10S	BW	40 05 23	3
Taps	1/8 thru 2-1/2	Forged Stainless Steel Tee: ASTM A182-F316L, Dim. per ASME B16.11	Class 3000	SW	40 05 23	
		Wrought Stainless Steel Tee: ASTM A403-WP316L, Dim. per ASME B16.9	Sch. 40S	SW	40 05 23	
	3 thru 12	Forged Stainless Steel Half Coupling: ASTM A182-F316L, Dim. per ASME B16.11	Class 3000	FP Beveled Fillet Weld	40 05 23	
		Forged Stainless Steel Olet: ASTM A182-F316L, Dim. per MSS SP-97	Class 3000	FP Beveled Fillet Weld	40 05 23	
Grooved Coupling	All	None	—	—	—	
Flanges	All	None	—	—	—	
FLG Bolts, nuts and hardware	All	None	—	—	—	
Flange gaskets	All	None	—	—	—	
Mechanical Coupling Gaskets	All	None	—	—	—	

Process Service Identifier	AS	MBW	MCH	MFE
Process Service	Air Scour	Membrane Backwash Water	Membrane CIP Heating	Membrane Filtration Effluent

Area Exposure Types: Indoor - Buried [Includes Encased and Embeded] [IB]

Component	Line Size, in	Material	Rating	Conn./Joints	Spec Section	Key Notes
Compression and Push-On Gaskets	All	None	—	—	—	
Valves	All	None	—	—	—	
Insulation	All	None	—	—	—	

END OF SECTION

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SECTION 40 05 02.03

CARBON STEEL PIPE SCHEDULE

Process Service Identifier	D	FW	GBW	GEC	GEI	OF	PW	RBW	RW	SBS
Process Service	Drain	Finished Water	GAC Backwash Water	GAC Effluent (Complete)	GAC Effluent (Interstage)	Overflow	Potable Water	Recycled Backwash Water	Raw Water	Settled Backwash Solids
Process Service Identifier	SBW	WBW								
Process Service	Settled Backwash Water	Waste Backwash Water								

Area Exposure Types | Design Requirements | Testing Requirements

Process Service Identifier	Indoor Exposed (IE)	Outdoor Exposed (OE)	Tank Submerged (TS)	Design Pressure (psig)	Design Temperature (°F)	Test Pressure (psig)	Test Duration (min)	Test Medium
D			●	30	140	45	120	Water
FW	●		●	100	120	150	120	Water
GBW	●			100	120	150	120	Water
GEC	●		●	100	120	150	120	Water
GEI	●			100	120	150	120	Water
OF		●		30	140	45	120	Water
PW	●			100	120	150	120	Water
RBW		●	●	100	140	150	120	Water
RW	●			100	120	150	120	Water
SBS		●	●	100	140	150	120	Water
SBW		●	●	100	140	150	120	Water
WBW		●	●	100	140	150	120	Water

Process Service Identifier	D	FW	GBW	GEC	GEI	OF	PW	RBW	RW	SBS
Process Service	Drain	Finished Water	GAC Backwash Water	GAC Effluent (Complete)	GAC Effluent (Interstage)	Overflow	Water	Recycled Backwash Water	Water	Settled Backwash Solids
Process Service Identifier	SBW	WBW								
Process Service	Settled Backwash Water	Waste Backwash Water								

General Requirements

A. All piping shall be designed, fabricated and inspected in accordance with ASME B31.3.

B. Full-Faced flanges mated with raised face flanges are not permitted.

C. Mating flanges for pipe shall be of the same Standard, Class and Series. Mating flanges at valves and equipment shall have specified rating and matching drilling pattern.

D. Threads per ASME B1.20.1.

E. Match metal alloy/grade/type for any metal welded to pipe or fittings. (e.g. Do not weld carbon steel to stainless steel. Weld Type 316L to Type 316L pipe material.)

F. All materials shall be certified for use in a potable water system (ASNI/NSF 61) and shall meet the requirements specified therein.

Key Notes

1. Flange bolt length per ASME B16.5 plus three additional threads. Hex head bolt dimensions per ASME B18.2.1. Class 2A standard coarse series threads per ASME B1.1, standard coarse thread series. Hex nut dimensions per ASME B18.2.2 (Heavy Hex). Class 2B standard coarse series threads per ASME B1.1.
2. Provide Long Radius Elbows. Provide full flow fittings. Segmentally welded fittings are not acceptable.
3. Weld Threadolet or Half Coupling prior to installing lining and coating.
4. PGRV (Proprietary Groove): Victaulic Advanced Groove System or Approved Equal.
5. Provide rigid couplings for 3-inch thru 12-inch except pipe installed on pipe racks (pipe/utility tunnels or chases) or for connections to pumps and blowers.

Process Service Identifier	D	FW	GBW	GEC	GEI	OF	PW	RBW	RW	SBS
Process Service	Drain	Finished Water	GAC Backwash Water	GAC Effluent (Complete)	GAC Effluent (Interstage)	Overflow	Water	Recycled Backwash Water	Water	Settled Backwash Solids
Process Service Identifier	SBW	WBW								
Process Service	Settled Backwash Water	Waste Backwash Water								

Area Exposure Types: Indoor – Exposed [IE], Outdoor - Exposed [OE], Tank Submerged [TS]

Component	Line Size, in	Material	Rating	Conn./Joints	Spec Section	Key Notes
Pipe	1/4 thru 1-1/2	Steel: ASTM A53, Gr B, Type E or Type S, Galvanized, Dim. Per ASME B36.10	Sch. 40	THD, SW	40 05 24	
	2 thru 12	Steel: ASTM A53, Gr B, Type E or Type S, Dim. Per ASME B36.10	Sch. 40	CGRV, RGRV, FLG, BW	40 05 24	
Lining for Pipe & Fittings	1/4 thru 1-1/2	None	—	—	—	
	2 thru 12	Liquid Epoxy: Factory Applied, AWWA C210, NSF 61 certified	16 mils DFT	—	40 05 24	
		Fusion-Bonded Epoxy: Factory Applied, AWWA C213, NSF 61 certified	12 mils CFT	—	40 05 24	
		Polyurethane: Factory Applied, AWWA C222, NSF 61 certified	Thk. per Std.	—	40 05 24	
External Coating	All	Liquid Epoxy: Factory Applied, AWWA C210	16 mils DFT	—	40 05 24	
		Three Coat Zinc/Epoxy/Urethane: Factory Applied, AWWA C218	16 mils DFT	—	40 05 24	
		Fusion-Bonded Epoxy: Factory Applied, AWWA C213	12 mils CFT	—	40 05 24	
		Polyurethane: Factory Applied, AWWA C222	Thk. per Std.	—	40 05 24	
	Valves	Epoxy: Manufacturer's standard, primer and finish coat, Factory Applied	—	—	—	
Fittings	1/4 thru 1-1/2	Forged Steel: ASTM A182-F304, Galvanized, Dim. per ASME B16.11	Sch. 40 or Std. Wt.	THD, SW	40 05 24	
	2 thru 12	Wrought Steel Grooved End: ASTM A234-WPB, r/D dim. per ASME B16.9, ASTM A53 grooved tangents per manufacturer's standard dim.	Sch. 40 or Std. Wt.	CGRV, PGRV	40 05 24	2
		Wrought Steel: ASTM A234-WPB, Dim. per ASME B16.9	Sch. 40 or Std. Wt.	BW, FLG	40 05 24	2
Taps	1/4 thru 1-1/2	Forged Steel Tee: ASTM A105, galvanized, Dim. per ASME B16.11	Class 3000	THD, SW	40 05 24	
	2 thru 12	Forged Steel Threadolet or Half Coupling: ASTM A105, Dim. per ASME B16.11	Class 3000	FP Beveled Fillet Weld	40 05 24	3
Grooved Coupling	2 thru 12	Rigid Coupling: ASTM A536-Gr 65/45/12, Groove Dim. per AWWA C606	150 psi	CGRV, RGRV, PGRV	40 05 24	4,5
		Flexible Coupling: ASTM A536-Gr 65/45/12, Groove Dim. per AWWA C606	150 psi	CGRV, RGRV, PGRV	40 05 24	4,5
Flange	2 thru 12	Forged Steel: ASTM A105, FF, Dim. per ASME B16.5	Class 150	LWN, WN, SO	40 05 24	
		Plate Steel: FF, Material and Dim. per AWWA C207	Class D	SO	40 05 24	
FLG Bolts, nuts and hardware	All	Alloy Steel Bolts: ASTM A193-Gr B8M with Carbon Steel Nuts: ASTM A194-Gr B8 heavy hex	All	—	—	1

Process Service Identifier	D	FW	GBW	GEC	GEI	OF	PW	RBW	RW	SBS
Process Service	Drain	Finished Water	GAC Backwash Water	GAC Effluent (Complete)	GAC Effluent (Interstage)	Overflow	Water	Recycled Backwash Water	Water	Settled Backwash Solids
Process Service Identifier	SBW	WBW								
Process Service	Settled Backwash Water	Waste Backwash Water								

Area Exposure Types: Indoor – Exposed [IE], Outdoor - Exposed [OE], Tank Submerged [TS]

Component	Line Size, in	Material	Rating	Conn./Joints	Spec Section	Key Notes
Flange gaskets	2 thru 12	Viton/FKM, PTFE	1/8 in Thk.	FLG	40 05 01	
Mechanical Coupling Gaskets	2 thru12	Viton/FKM, PTFE	—	CGRV, RGRV, PGRV	40 05 01	
Compression and Push-On Gaskets	All	None	—	—	—	
Valves	1/4 thru 1-1/2	Ball: Stainless Steel (316) Body/Ball	—	THD	40 05 60	
		Globe: Stainless Steel (316)	—	THD	40 05 60	
		Swing Check: Stainless Steel (316)	—	THD	40 05 60	
	2 thru 12	See Valve Lists on Drawing G-00-006	—	FLG	—	
Insulation	All	None	—	—	—	

END OF SECTION

SECTION 40 05 02.06

STAINLESS STEEL TUBING SCHEDULE

Process Service Identifier	MIT	PAS	SA
Process Service	Membrane Integrity Test	Plant Air System	Sample

Area Exposure Types | Design Requirements | Testing Requirements

Process Service Identifier	Indoor Buried (IB)	Outdoor Exposed (OE)	Design Pressure (psig)	Design Temperature (°F)	Test Pressure (psig)	Test Duration (min)	Test Medium
MIT	●	●	150	150	225	120	Nitrogen
PAS	●	●	150	150	225	120	Nitrogen
SA	●		100	120	150	120	Water

General Requirements

A. Comply with the provisions of Section 40 05 01 in addition to the requirements specified herein. Refer to Section 40 05 02 for definitions of abbreviations and acronyms used in this schedule.

B. Pipe threads per ASME B1.20.1.

C. Match metal alloy/grade/type for any metal welded to pipe or fittings. (e.g. Do not weld carbon steel to stainless steel; weld Type 316L to Type 316L pipe material.)

D. Provide unions or flanges as shown on drawings to allow for pipe disassembly and maintenance access.

E. All materials shall be certified for use in a potable water system (ANSI/NSF 61) and shall meet the requirements specified therein.

Key Notes

1. Furnish threaded adaptors at threaded end connections on valves.

Process Service Identifier	MIT	PAS	SA
Process Service	Membrane Integrity Test	Plant Air System	Sample

Area Exposure Types: Indoor - Exposed [IE], Indoor - Buried [Includes Embedded and Encased] [IB]

Component	Line Size, in	Material	Rating	Conn./Joints	Spec Section	Key Notes
Pipe	1/8 thru 3/8	Stainless Steel Tube: ASTM A269-TP316L	0.035 in. wall	CPRSN	40 05 23	
	1/2 thru 3/4	Stainless Steel Tube: ASTM A269-TP316L	0.065 in. wall	CPRSN	40 05 23	
	1	Stainless Steel Tube: ASTM A269-TP316L	0.083 in. wall	CPRSN	40 05 23	
Lining for Pipe & Fittings	All	None	—	—	—	
External Coating	Pipe and Fittings	None	—	—	—	
External Coating	Valves	Manufacturer's Standard Primer or Primer and Finish Coating: Shop or Factory Applied	—	—	—	
Fittings	All	Stainless Steel Compression: ASTM A276-Type 316/316L or ASTM A182-TP316, nut and double ferrule, rating per Spec. Section.	—	CPRSN	40 05 23	
Taps	All	Stainless Steel Compression Tee: ASTM A276-Type 316/316L or ASTM A182-TP316, nut and double ferrule, rating per Spec. Section.	—	CPRSN	40 05 23	
Grooved Coupling	All	None	—	—	—	
Flanges	All	None	—	—	—	
FLG Bolts, nuts and hardware	All	None	—	—	—	
Flange gaskets	All	None	—	—	—	
Mechanical Coupling Gaskets	All	None	—	—	—	
Compression and Push-On Gaskets	All	None	—	—	—	
Valves	All	Ball: Stainless Steel Body/Ball	—	THD	40 05 60	1
		Check: Stainless Steel Silent Check		THD	40 05 60	1
		Needle: 316 Stainless Steel Body and Stem	—	THD	40 05 60	1
Insulation	All	None	—	—	—	

END OF SECTION

SECTION 40 05 02.13

HDPE PIPE SCHEDULE

Process Service Identifier	CBW	D	FW	GEC	PW	RBW	RW	SBS	SBW	WBW
Process Service	Chemical Backwash Water	Drain	Finished Water	GAC Effluent (Complete)	Potable Water	Recycle Backwash Water	Raw Water	Settled Backwash Solids	Settled Backwash Water	Waste Backwash Water

Area Exposure Types | Design Requirements | Testing Requirements

Process Service Identifier	Outdoor Buried (OB)	Design Pressure (psig)	Design Temperature (°F)	Test Pressure (psig)	Test Duration (min)	Test Medium
CBW	●	30	120	45	120	Water
D	●	30	120	45	120	Water
FW	●	100	120	150	120	Water
GEC	●	100	120	150	120	Water
PW	●	100	120	150	120	Water
RBW	●	100	120	150	120	Water
RW	●	100	120	150	120	Water
SBS	●	100	120	150	120	Water
SBW	●	100	120	150	120	Water
WBW	●	100	120	150	120	Water

Process Service Identifier	CBW	D	FW	GEC	PW	RBW	RW	SBS	SBW	WBW
Process Service	Chemical Backwash Water	Drain	Finished Water	GAC Effluent (Complete)	Potable Water	Recycle Backwash Water	Raw Water	Settled Backwash Solids	Settled Backwash Water	Waste Backwash Water

General Requirements

A. Comply with the provisions of Section 40 05 01 in addition to the requirements specified herein. Refer to Section 40 05 02 for definitions of abbreviations and acronyms used in this schedule.

B. Full-Faced flanges mated with raised face flanges are not permitted.

C. Mating flanges for pipe shall be of the same Standard, Class and Series. Mating flanges at valves and equipment shall have specified rating and matching drilling pattern.

D. Pipe threads per ASME B1.20.1.

E. Match metal alloy/grade/type for any metal welded to pipe or fittings. (e.g. Do not weld carbon steel to stainless steel; weld Type 316L to Type 316L pipe material.)

F. All materials shall be certified for use in a potable water system (ANSI/NSF 61) and shall meet the requirements specified therein.

Key Notes

1. Flange bolt length per ASME B16.5 plus three additional threads. Hex head bolt dimensions per ASME B18.2.1. Class 2A standard coarse series threads per ASME B1.1, standard coarse thread series. Hex nut dimensions per ASME B18.2.2 (Heavy Hex). Class 2B standard coarse series threads per ASME B1.1.
2. Provide Long Radius Elbows. Provide full flow fittings. Segmentally welded fittings are not acceptable.
3. Provide long radius five cut mitered elbows for segmentally welded fittings.
4. Provide concrete surround or encasement for pipe buried below structures.
5. Except at flanged connections at valves, flanged connections/joints not permitted on buried Ductile Iron Pipe.
6. Provide magnetic tracer tape.
7. Provide AWWA standard 2-inch square nut operator, extension stem, and valve box for buried valves.
8. HPEG (HDPE Plain End with Gripping Teeth): Victaulic Style 995N, Victaulic Style 905, or Approved Equal.
9. HGRV (HDPE Groove Coupling): Victaulic Style 908 or Approved Equal.
10. Wall thickness and pressure rating as calculated per AWWA Manual M11 will match or exceed that of connecting piping. Increase wall thickness as necessary.

Process Service Identifier	CBW	D	FW	GEC	PW	RBW	RW	SBS	SBW	WBW
Process Service	Chemical Backwash Water	Drain	Finished Water	GAC Effluent (Complete)	Potable Water	Recycle Backwash Water	Raw Water	Settled Backwash Solids	Settled Backwash Water	Waste Backwash Water

Area Exposure Types: Outdoor - Buried [Includes Embedded and Encased] [OB]

Component	Line Size, in	Material	Rating	Conn./Joints	Spec Section	Key Notes
Pipe	1/2 thru 3	High Density Polyethylene: ASTM D 3350-445574C/PE 4710, NSF 61 certified, Dim. per ASTM D3035/AWWA C901	IPS DR 21	FLG,BFW,EFSW	40 05 33.13	4, 6
	4 thru 20	High Density Polyethylene: ASTM D 3350-445574C/PE 4710, NSF 61 certified, Dim. per ASTM F714/AWWA C906	IPS DR 21	FLG, BFW, EFSW, HPEG, HGRV	40 05 33.13	4, 7, 8, 9
Lining for Pipe & Fittings	All	None	—	—	—	
External Coating	All	None	—	—	—	
Fittings	1/2 thru 3	HDPE Molded Fittings: ASTM D 3350-445574C/PE 4710, NSF 61 certified, Dim. per ASTM D3261/ASTM F1055/ASTM D2683	IPS SDR 21	FLG, FSW, EFSW, BFW, HPEG	40 05 33.13	4, 6, 8
	4 thru 12	HDPE Molded Fittings: ASTM D 3350-445574C/PE 4710, NSF 61 certified, Dim. per ASTM D3261/ASTM F1055/ASTM D2683	IPS SDR 21	FLG, FSW, EFSW, BFW, HPEG, HGRV	40 05 33.13	2, 4, 9, 10
		HDPE Long Radius Sweep Bend: ASTM D 3350-445574C/PE 4710, NSF 61 certified, Dim. per ASTM D 3035/AWWA C901	IPS SDR 21	FLG, FSW, EFSW, BFW, HPEG, HGRV	40 05 33.13	2, 4, 8, 9
	14 thru 20	HDPE Fabricated Fittings: ASTM D 3350-445574C/PE 4710, NSF 61 certified, Dim. per ASTM F2206	IPS SDR 13.5	FLG, BFW, HPEG, HGRV	40 05 33.13	3, 4, 8, 9
		HDPE Long Radius Sweep Bend: ASTM D 3350-445574C/PE 4710, NSF 61 certified, Dim. per ASTM F714/AWWA C906	IPS SDR 21	FLG, BFW, HPEG, HGRV	40 05 33.13	2, 4, 8, 9
Taps	1/2 thru 3	Molded HDPE Tee: ASTM D 3350-445574C/PE 4710, NSF 61 certified, Dim. per ASTM D3261, with reducers and HDPE to 316 Stainless Steel MNPT transition	IPS SDR 21	FLG, FSW, EFSW, BFW, HPEG	40 05 33.13	8
	4 thru 12	Molded HDPE Tee: ASTM D 3350-445574C/PE 4710, NSF 61 certified, Dim. per ASTM D3261, with reducers and HDPE to 316 Stainless Steel MNPT transition	IPS SDR 21	FLG, FSW, EFSW, BFW, HPEG, HGRV	40 05 33.13	8, 9
	14 thru 54	Electrofusion Branch Saddle Tap: ASTM D 3350-445574C/PE 4710, NSF 61 certified, Dim. per ASTM F1055, with reducers and HDPE to 316 Stainless Steel MNPT transition	IPS SDR 21	EFSW, FSW	40 05 33.13	
Grooved Coupling	8 thru 36	Flexible Coupling: ASTM A536 Gr 65/45/12, Groove Dim. per manufacturer's standard	150 psi	HGRV	40 05 33.13	9
	2 thru 20	Flexible Coupling: ASTM A536 Gr 65/45/12, Gripping Teeth per manufacturer's standard	150 psi	HPEG	40 05 33.13	8

Process Service Identifier	CBW	D	FW	GEC	PW	RBW	RW	SBS	SBW	WBW
Process Service	Chemical Backwash Water	Drain	Finished Water	GAC Effluent (Complete)	Potable Water	Recycle Backwash Water	Raw Water	Settled Backwash Solids	Settled Backwash Water	Waste Backwash Water

Area Exposure Types: Outdoor - Buried [Includes Embedded and Encased] [OB]

Component	Line Size, in	Material	Rating	Conn./Joints	Spec Section	Key Notes
Flanges	All	Ductile Iron Backing Ring: ASTM A536, Polypropylene coated, LJ, Dim. per ANSI B16.5 with stub end flange adapter with Stub End Flange Adapters: ASTM D 3350-445574C/PE 4710, NSF 61 certified, Dim. per ASTM D3261	Class 150	BFW x FLG IPS SDR 17	40 05 33.13	
FLG Bolts, nuts and hardware	All	Carbon Steel Bolts: ASTM A307-B with Xlyan fluoropolymer coating, Tripac 2000 Blue or approved equal, with Carbon Steel Nuts: ASTM A563-A with Xlyan fluoropolymer coating, Tripac 2000 Blue or approved equal	—	—	—	1
Flange Gaskets	All	Viton FKM, PTFE	1/8 in Thk	FLG	40 05 01	
Mechanical Coupling Gaskets	All	Viton FKM, PTFE	—	HPEG, HGRV	40 05 01	
Compression and Push-On Gasket	All	None	—	—	—	
Valves	All	See Valve List on Drawing G-00-006	—	—	—	5
Insulation	All	None	—	—	—	

END OF SECTION

SECTION 40 05 02.19

DUCTILE IRON PIPE SCHEDULE

Process Service Identifier	CBW	D	FW	GEC	GBW	MBW	MCR	MCW	MFE	PW
Process Service	Chemical Backwash Water	Drain	Finished Water	GAC Effluent (Complete)	GAC Backwash Water	Membrane Backwash Water	Membrane CIP Recirculation	Membrane CIP Waste	Membrane Filtration Effluent	Potable Water
Process Service Identifier	RW	WBW								
Process Service	Raw Water	Waste Backwash Water								

Area Exposure Types | Design Requirements | Testing Requirements

Process Service Identifier	Indoor Buried (IB)	Outdoor Exposed (OE)	Design Pressure (psig)	Design Temperature (°F)	Test Pressure (psig)	Test Duration (min)	Test Medium
CBW	●		30	120	45	120	Water
D	●		30	120	45	120	Water
FW	●		100	120	150	120	Water
GEC	●		100	120	150	120	Water
GBW	●		100	120	150	120	Water
MBW	●		100	120	150	120	Water
MCR	●		100	120	150	120	Water
MCW	●		100	120	150	120	Water
MFE	●		100	120	150	120	Water
PW	●		100	120	150	120	Water
RW	●	●	100	120	150	120	Water
WBW	●		100	120	150	120	Water

Process Service Identifier	CBW	D	FW	GEC	GBW	MBW	MCR	MCW	MFE	PW
Process Service	Chemical Backwash Water	Drain	Finished Water	GAC Effluent (Complete)	GAC Backwash Water	Membrane Backwash Water	Membrane CIP Recirculation	Membrane CIP Waste	Membrane Filtration Effluent	Potable Water
Process Service Identifier	RW	WBW								
Process Service	Raw Water	Waste Backwash Water								

General Requirements

A. Comply with the provisions of Section 40 05 01 in addition to the requirements specified herein. Refer to Section 40 05 02 for definitions of abbreviations and acronyms used in this schedule.

B. Full-Faced flanges mated with raised face flanges are not permitted.

C. Mating flanges for pipe shall be of the same Standard, Class and Series. Mating flanges at valves and equipment shall have specified rating and matching drilling pattern.

D. Pipe threads per ASME B1.20.1.

E. Match metal alloy/grade/type for any metal welded to pipe or fittings. (e.g. Do not weld carbon steel to stainless steel; weld Type 316L to Type 316L pipe material.)

F. All materials shall be certified for use in a potable water system (ANSI/NSF 61) and shall meet the requirements specified therein.

Key Notes

1. Flange bolt length per ASME B16.5 plus three additional threads. Hex head bolt dimensions per ASME B18.2.1. Class 2A standard coarse series threads per ASME B1.1, standard coarse thread series. Hex nut dimensions per ASME B18.2.2 (Heavy Hex). Class 2B standard coarse series threads per ASME B1.1.
2. Provide concrete surround or encasement for pipe buried below structures.
3. Except at flanged connections at valves, flanged connections/joints not permitted on buried Ductile Iron Pipe.
4. FNPT tap at factory installed tapping boss. Taps at other locations on pipe and fittings are not permitted.
5. Provide rigid couplings for 3-inch thru 12-inch except pipe installed on pipe racks (pipe/utility tunnels or chases) or for connections to pumps and blowers.
6. Coating may be omitted for pipe encased in concrete or grout.

Process Service Identifier	CBW	D	FW	GEC	GBW	MBW	MCR	MCW	MFE	PW
Process Service	Chemical Backwash Water	Drain	Finished Water	GAC Effluent (Complete)	GAC Backwash Water	Membrane Backwash Water	Membrane CIP Recirculation	Membrane CIP Waste	Membrane Filtration Effluent	Potable Water
Process Service Identifier	RW	WBW								
Process Service	Raw Water	Waste Backwash Water								

Area Exposure Types: Indoor - Buried [Includes Embedded and Encased] [IB]

Component	Line Size, in	Material	Rating	Conn./Joints	Spec Section	Key Notes
Pipe	4 thru 12	Ductile Iron: AWWA C151	Pr. Class 350	RMJ	40 05 19	2, 3, 6
Lining for Pipe & Fittings	All	Liquid Epoxy: AWWA C210, NSF 61 certified, Factory Applied	16 mils DFT	—	40 05 19	
		Fusion-Bonded Epoxy: AWWA C213, NSF 61 certified, Factory Applied	12 mils CFT	—	40 05 19	
External Coating	All	Fusion Bonded Epoxy Coating: AWWA C116, NSF 61 certified, Factory Applied	Thk. per Std	—	40 05 19	
	Valves	No Buried Valves	—	—	—	
Fittings	All	Ductile Iron: AWWA C110 or AWWA C153	250 psi	RMJ	40 05 19	2, 3
Taps	All	Steel Short Nipple: ASTM A53, seamless-Gr B, Type E or Type S, galvanized, Dim. Per ASME B36.10	Sch. 40	THD	40 05 19	4
Grooved Coupling	All	None	—	—	—	
Flanges	All	None	—	—	—	
Bolts, nuts and hardware	All	Carbon Steel Bolts: ASTM A307-B with Xlyan fluoropolymer coating, Tripac 2000 Blue or approved equal, with Carbon Steel Nuts: ASTM A563-A with Xlyan fluoropolymer coating, Tripac 2000 Blue or approved equal	—	—	—	1
Flange gaskets	All	None	—	—	—	
Mechanical Coupling Gaskets	All	None	—	—	—	
Compression and Push-On Gasket	All	Viton/FKM, PTFE	—	—	—	
Valves	All	None	—	—	—	
Insulation	All	None	—	—	—	

Process Service Identifier	CBW	D	FW	GEC	GBW	MBW	MCR	MCW	MFE	PW
Process Service	Chemical Backwash Water	Drain	Finished Water	GAC Effluent (Complete)	GAC Backwash Water	Membrane Backwash Water	Membrane CIP Recirculation	Membrane CIP Waste	Membrane Filtration Effluent	Potable Water
Process Service Identifier	RW	WBW								
Process Service	Raw Water	Waste Backwash Water								

Area Exposure Types: Outdoor - Exposed [OE]

Component	Line Size, in	Material	Rating	Conn./Joints	Spec Section	Key Notes
Pipe	4 thru 48	Ductile Iron: AWWA C151	Thk. Class 53	PGRV, CGRV, FLG	40 05 19	
Lining for Pipe & Fittings	All	Fusion Bonded Epoxy Lining and Coating: AWWA C116, NSF 61 certified, Factory Applied	Thk, per Std.	—	40 05 19	
External Coating	All	Fusion Bonded Epoxy Lining and Coating: AWWA C1116, Factory Applied	Thk. per Std.	—	40 05 19	
	Valves	Epoxy: Manufacturer's standard, primer and finish coat, Factory Applied	—	—	—	
Fittings	4 thru 36	Ductile Iron: ASTM A536-Gr 65/45/12, Dim. per AWWA C110 or AWWA C153	150 psi	CGRV	40 05 19	
	All	Ductile Iron: ASTM A536-Gr 65/45/12, Dim. per AWWA C110 or AWWA C153	150 psi	FLG	40 05 19	
Taps	All	Steel Short Nipple: ASTM A53, seamless-Gr B, Type E or Type S, galvanized, Dim. Per ASME B36.10	Sch. 40	THD	40 05 19	4
Grooved Couplings	All	Rigid Coupling: ASTM A536-Gr 65/45/12, Groove Dim. per AWWA C606	150 psi	CGRV	40 05 19	5
		Flexible Coupling: ASTM A536-Gr 65/45/12, Groove Dim. per AWWA C606	150 psi	CGRV	40 05 19	
Flanges	All	Ductile iron: AWWA C115 for pipe, AWWA C110 for fittings, Dim. per ASME B16.1-Class 125	250 psi	FLG	40 05 19	
FLG Bolts, nuts and hardware	All	Alloy Steel Bolts: ASTM A193-Gr B7 with Carbon Steel Nuts: ASTM A194-Gr 2H heavy hex	All	—	—	1
Flange Gaskets	4 thru 48	Viton/FKM, PTFE	1/8 in Thk.	FLG	40 05 01	
Mechanical Coupling Gaskets	4 thru 48	Viton/FKM, PTFE	—	CGRV	40 05 01	
Compression and Push-On Gaskets	All	None	—	—	—	
Valves	1/4 thru 3	Ball: Stainless Steel (316) Body/Ball	—	THD	40 05 60	
		Globe: Stainless Steel (316)	—	THD	40 05 60	
	4 thru 12	See Valve Lists on Drawing G-00-006	—	—	—	
Insulation	1/4 thru 8	Cellular Elastomeric: ASTM C534-Type I Grade 1, Low Temperature Range, Freeze Protection, PVC Jacket/Covers	1 in. Thk		40 42 00	

END OF SECTION

SECTION 40 05 02.54

PFA TUBING SCHEDULE

Process Service Identifier	BWC	CAS	CLS	SAS	SB	SHC	SHX
Process Service	Backwash Water Coagulant	Citric Acid System	Clorine Solution	Sulfiruc Acid System	Sodium Bisulfite System	Sodium Hypochlorite System	Sodium Hydroxide System

Area Exposure Types | Design Requirements | Testing Requirements

Process Service Identifier	Indoor Exposed (IE)	Indoor Buried (IB)	Outdoor Buried (OB)	Design Pressure (psig)	Design Temperature (°F)	Test Pressure (psig)	Test Duration (min)	Test Medium
BWC	See Key Note 1,2	See Key Note 2	See Key Note 2	100	120	150	120	Water
CAS	See Key Note 1			100	120	150	120	Water
CLS	See Key Note 3,4	See Key Note 3		100	120	150	120	Water
SAS	See Key Note 1			100	120	150	120	Water
SB	See Key Note 1			100	120	150	120	Water
SHC	See Key Note 1,2	See Key Note 2		100	120	150	120	Water
SHX	See Key Note 1,2			100	120	150	120	Water

General Requirements

A. Comply with the provisions of Section 40 05 01 in addition to the requirements specified herein. Refer to Section 40 05 02 for definitions of abbreviations and acronyms used in this schedule.

B. Pipe threads per ASME B1.20.1.

C. All materials shall be certified for use in a potable water system (ANSI/NSF 61) and shall meet the requirements specified therein.

Key Notes

1. Install CPVC piping as primary pipe for all components within the chemical dosing system assembly in accordance with Section 40 05 02.65. Install PFA tubing from each chemical storage tank to the dosing system as well as from each dosing system to the chemical injection point.
2. Provide secondary containment in accordance with Section 40 05 31.19 for the areas defined in the table above, in Section 40 05 02, and Section 40 05 02.65. Secondary containment piping system material shall be as specified in Section 40 05 02.65. Secondary containment not required within chemical storage and pumping area unless otherwise defined in the drawings.
3. Install CPVC piping as primary pipe for all components within the chorine room in accordance with Section 40 05 02.65. Transition to PFA tubing prior to entering the wall penetration between the chlorine room and the main process area.
4. Provide secondary containment in accordance with Section 40 05 31.19 for the areas defined in the table above, in Section 40 05 02, and Section 40 05 02.65. Secondary containment piping system material shall be as specified in Section 40 05 02.65. Secondary containment not required within the chlorine room.

Process Service Identifier	BWC	CAS	CLS	SAS	SB	SHC	SHX
Process Service	Backwash Water Coagulant	Citric Acid System	Clorine Solution	Sulfiruc Acid System	Sodium Bisulfite System	Sodium Hypochlorite System	Sodium Hydroxide System

Area Exposure Types: Indoor - Exposed [IE], Indoor - Buried [Including Encased and Embedded] [IB], Outdoor - Buried [OB]

Component	Line Size, in	Material	Rating	Conn./Joints	Spec Section	Key Notes
Pipe	1/2	Flexible Virgin PFA tubing suitable for flaring and available in continuous lengths of 23, 50, 100, 250, and 1,000 feet	200 psig	FLRD	40 05 54	
Lining for Pipe & Fittings	All	None	—	—	—	
External Coating	All	None	—	—	—	
	Valves	None	—	—	—	
Fittings	All	PVDF Flare-type (no threads exposed to fluid)	—	FLRD	40 05 54	
Taps	All	None	—	—	—	
Grooved Coupling	All	None	—	—	—	
Flanges	All	None	—	—	—	
FLG Bolts, nuts and hardware	All	None	—	—	—	
Flange gaskets	All	None	—	—	—	
Mechanical Coupling Gaskets	All	None	—	—	—	
Compression and Push-On Gaskets	All	None	—	—	—	
Valves	1/4 thru 3	None	—	—	—	
Insulation	All	None	—	—	—	

END OF SECTION

SECTION 40 05 02.65

CPVC PIPE SCHEDULE

Process Service Identifier	BWC	CAS	CBS	CBW	CLG	CLS	D	MCR	MCW	OF
Process Service	Backwash Water Coagulant	Citric Acid System	Chlorine Booster System	Chemical Backwash Water	Chlorine Gas	Chlorine Solution	Drain	Membrane CIP Recirculation	Membrane CIP Wastewater	Overflow
Process Service Identifier	SAS	SB	SHC	SHX	UW	V	WBW			
Process Service	Sulfuric Acid	Sodium Bisulffite	Soldium Hypochlorite	Sodium Hydroxide	Utility Water	Vent	Waste Backwash Water			

Area Exposure Types | Design Requirements | Testing Requirements

Process Service Identifier	Indoor Exposed (IE)	Indoor Buried (IB)	Outdoor Buried (OB)	Design Pressure (psig)	Design Temperature (°F)	Test Pressure (psig)	Test Duration (min)	Test Medium
BWC	See Key Note 3, 5	See Key Note 5	See Key Note 5	100	120	150	120	Water
CAS	See Key Note 5			100	120	150	120	Water
CBS	●			100	120	150	120	Water
CBW	●			100	120	150	120	Water
CLG	●			100	120	150	120	Water
CLS	See Key Note 4,6	See Key Note 4		100	120	150	120	Water
D	●			100	120	150	120	Water
MCR	●			100	120	150	120	Water
MCW	●			100	120	150	120	Water
OF	●			100	120	150	120	Water
SAS	See Key Note 5			100	120	150	120	Water
SB	See Key Note 5			100	120	150	120	Water
SHC	See Key Note 3, 5	See Key Note 5		100	120	150	120	Water
SHX	See Key Note 3, 5			100	120	150	120	Water
UW	●			100	120	150	120	Water
V	●			100	120	150	120	Water
WBW	●			100	120	150	120	Water

Process Service Identifier	BWC	CAS	CBS	CBW	CLG	CLS	D	MCR	MCW	OF
Process Service	Backwash Water Coagulant	Citric Acid System	System	Chemical Backwash Water	Gas	Chlorine Solution	Drain	Membrane CIP Recirculation	Membrane CIP Wastewater	Overflow
Process Service Identifier	SAS	SB	SHC	SHX	UW	V	WBW			
Process Service	Sulfuric Acid	Sodium Bisulffite	Soldium Hypochlorite	Sodium Hydroxide	Utility Water	Vent	Waste Backwash Water			

General Requirements

A. Comply with the provisions of Section 40 05 01 in addition to the requirements specified herein. Refer to Section 40 05 02 for definitions of abbreviations and acronyms used in this schedule.

B. Full-Faced flanges mated with raised face flanges are not permitted.

C. Solvent welding of CPVC piping performed with Weld-On 724 (ASTM F 493, NSF/ANSI 14, and NSF/ANSI 61) or Approved Equal. Universal plastic pipe solvent is not acceptable. Prior to solvent welding, clean pipe joints to remove all loose debris and prime with a compatible primer. Primer shall stain piping.

D. Mating flanges for pipe shall be of the same Standard, Class and Series. Mating flanges at valves and equipment shall have specified rating and matching drilling pattern.

E. All materials shall be certified for use in a potable water system (ANSI/NSF 61) and shall meet the requirements specified therein.

Key Notes

1. Flange bolt length per ASME B16.5 plus three additional threads. Hex head bolt dimensions per ASME B18.2.1. Class 2A standard coarse series threads per ASME B1.1, standard coarse thread series. Hex nut dimensions per ASME B18.2.2 (Heavy Hex). Class 2B standard coarse series threads per ASME B1.1.
2. Apply Anti-seize to stainless steel bolts before turning nut on flange bolts.
3. Install CPVC piping as secondary containment for all piping outside of the chemical storage and pumping area and where indicated on the process mechanical drawings.
4. Install CPVC piping as secondary containment for all piping outside of the chlorine room.
5. Install CPVC piping as primary pipe for all components within the chemical dosing system assembly. Install PFA tubing in accordance with Section 40 05 02.54 from each chemical storage tank to the dosing system as well as from each dosing system to the chemical injection point.
6. Install CPVC piping as primary pipe for components inside the Chlorine Room. Transition to PFA tubing in accordance with Section 40 05 02.54 as primary pipe just prior to entering the wall penetration into the main process area. Wall penetrations out of the chlorine room shall be made using the secondary containment pipe.
7. Buried valves are not permitted for this piping system schedule.
8. Coat all pipe exposed to sunlight. Omit coating for insulated pipe.
9. Ball valves are not permitted on sodium hypochlorite service (SHC).

Process Service Identifier	BWC	CAS	CBS	CBW	CLG	CLS	D	MCR	MCW	OF
Process Service	Backwash Water Coagulant	Citric Acid System	System	Chemical Backwash Water	Gas	Chlorine Solution	Drain	Membrane CIP Recirculation	Membrane CIP Wastewater	Overflow
Process Service Identifier	SAS	SB	SHC	SHX	UW	V	WBW			
Process Service	Sulfuric Acid	Sodium Bisulffite	Soldium Hypochlorite	Sodium Hydroxide	Utility Water	Vent	Waste Backwash Water			

Area Exposure Types: Indoor - Exposed [IE], Indoor Buried [Including Encased and Embedded] [IB], Outdoor - Buried [OB]

Component	Line Size, in	Material	Rating	Conn./Joints	Spec Section	Key Notes
Pipe	1/4 thru 24	CPVC: ASTM D1784-Class 23447 B, NSF 61 certified, Dim. Per ASTM F441	Sch. 80	SLV	40 05 31.13	4, 5
Lining for Pipe & Fittings	All	None	—	—	—	
External Coating	All	Latex Acrylic: Field Applied, Coating System L-2, Coat per Specification	3 mils DFT	—	09 90 00	7
	Valves	Latex Acrylic: Field Applied, Coating System L-2, Coat per Specification	3 mils DFT	—	09 90 00	7
Fittings	All	CPVC: ASTM D1784-Class 23447-B, Dim. Per ASTM F439	Sch. 80	SLV	40 05 31.13	4, 5, 6
Taps	All	CPVC Tee: ASTM D1784-Class 23447-B, Dim. Per ASTM F439, Reducing bushings as necessary	Sch. 80	SLV	40 05 31.13	4, 5, 6
Grooved Coupling	All	None	—	—	—	
Flanges	All	CPVC: ASTM A1784-Class 23447-B, FF, Dim. per ASME B16.5	Class 150	SLV x FLG	—	
FLG Bolts, nuts and hardware	All	Carbon Steel Bolts: ASTM A307-B with Xlyan fluoropolymer coating, Tripac 2000 Blue or approved equal with Carbon Steel Nuts: ASTM A563-A with Xlyan fluoropolymer coating, Tripac 2000 Blue or approved equal	—	—	—	1, 2
Flange gaskets	All	Viton/FKM, PTFE	—	FLG	40 05 01	
Mechanical Coupling Gaskets	All	None	—	—	—	
Compression and Push-On Gaskets	All	None	—	—	—	
Valves	1/4 thru 2	CPVC Ball: 40 05 63.06	—	SLV	40 05 60	3, 8
		CPVC Diaphragm: 40 05 74.06	—	SLV	40 05 60	3, 8
		CPVC Ball Check: 40 05 65.05	—	SLV	40 05 60	3, 8
	2 thru 24	See Valve Lists on Sheet G-00-006	—	—	—	
Insulation	All	None	—		—	

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SECTION 40 05 06

SPECIALTY COUPLINGS AND ADAPTERS FOR PROCESS PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes specialty couplings and adapters to provide electrical isolation, connect misaligned pipe, provide pipeline flexibility, provide disconnection/dismantling capabilities, and other specialty functions in pipelines.

B. Connections, couplings, and joints used to connect pipe segments and fittings that are not specifically designed to provide the capabilities of a specialty coupling are specified with the pipe materials.

C. Expansion Joints and Flexible Metal Hose for expansion control and pipe flexibility are specified in Section 40 05 06.23 – Expansion Joints and Flexible Metal Hose.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 61 45 – Area Exposure Designations
   2. Section 09 90 00 – Painting and Coating
   3. Section 40 05 01 – Piping Systems
   4. Section 40 05 02 – Piping System Schedules
   5. Section 40 05 06.23 – Expansion Joints and Flexible Metal Hose

1.03 REFERENCE STANDARDS

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document

Reference	Title
ASME B31.1	Power Piping
ASME B31.9	Building Service Piping

Reference	Title
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators Qualifications
ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Standard Specification for Stainless Steel Nuts
AWWA C105	Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C116	Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings
AWWA C153	Ductile-Iron Compact Fittings
AWWA C206	Field Welding of Steel Water Pipe
AWWA C213	Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
AWWA C219	Bolted, Sleeve-Type Couplings for Plain-End Pipe
AWWA C550	Protective Epoxy Coatings for Valves and Hydrants
AWWA C606	Grooved and Shouldered Joints
AWWA M11	AWWA M11 – Steel Pipe: A Guide for Design and Installation
NSF 61	Drinking Water System Components - Health Effects

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
      a. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations.
      b. Manufacturers' product data, catalog cuts, typical installation details, and dimensions for each size and type of specialty coupling or adapter furnished for the project.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide new specialty pipe couplings and adapters, free from defects and conforming to the requirements and standards specified in this Section.

B. Provide specialty couplings and adapters at locations indicated on drawings.

2.02 MECHANICAL COUPLINGS

A. Fasteners and Gaskets
   1. Except as otherwise specified in this Section, fasteners specified by Area Exposure Type. See Section 01 61 45 – Area Exposure Designations.
      a. Indoor Dry, Indoor Wet, and Outdoor: Manufacturer's Standard
      b. Process Corrosive, Headspace, Chemical Corrosive and Submerged: ASTM F593, Type 316 stainless steel, marking F593F.
      c. Non-corrosive high-strength, Low-alloy steel, ASTM A449 Gr 3, Class C or Class D, with metallurgy specified in AWWA C111, regardless of any other protective coating.
   2. Gasket material requirements for mechanical couplings are specified in the Piping System Schedules (Section 40 05 02.00 to Section 40 05 02.99).

B. Sleeve Couplings:
   1. Candidate manufacturer:
      a. Sleeve mechanical pipe couplings:
         1) Xylem/Smith Blair Type 411.
         2) Dresser Style 38.
         3) Approved equal, with the stop removed from the middle ring.
      b. Reducing Sleeve Couplings:
         1) Xylem/Smith Blair Type 415.
         2) Dresser Style 62.
         3) Approved equal.
      c. Sleeve Flanged Coupling Adapters:
         1) Romac FCA 501.
         2) Xylem/Smith Blair Type 913.
         3) Dresser Style 128.
         4) Approved equal.
      d. Gaskets: Match gasket material specified for Mechanical Coupling Gaskets in the Piping System Schedule for the associated Process Service.

C. Equipment Connection Fittings:
   1. Equipment connection fittings join flanged pipe ends with both lateral and angular misalignment adjustment between the axes of the pipes. In addition, equipment connection fittings provide full pressure thrust restraint between the field piping connection and equipment connection flanges.
      a. Equipment connection fittings consist of two flanged coupling adapters, a plain end section of pipe and thrust restraint tie rods and associated fittings designed to transmit thrust without transmitting shear to the thrust restraint rods and without compromising provisions for accommodating angular and parallel misalignment.
      b. Materials and features are to conform to the requirements established in this Section. Standard "dismantling joints" incorporate only one flanged coupling adapter and are not acceptable substitutes.
      c. Candidate manufacturers:
         1) Romac ECF Series

2) Baker Coupling Company, Los Angeles
3) Approved equal

2. Single sleeve of plain end piping conforming to the Piping System Schedule for the specified Process Service and of sufficient length to span the gap between the connection at the equipment and the connection at the field piping with Sleeve Flange Coupling Adapters at each end.
3. Provide thrust restraint by means of all-thread rod spanning between flanges. Rod nuts and spherical washer sets provide a ball-joint type self-aligning feature for all-thread thrust restraint rods. All-thread thrust restraint rods project through the flange and mating flange coupling adapter bolt holes or through holes in the restraint lug plates that extend beyond the flange diameter. Secure all-thread thrust restraint rod to the flanges with flange nuts or lug plates.
4. Provide lock washers between spherical washer sets and fastening nuts at both ends of all-thread thrust restraint rods. Double nutting with non-locking nuts is not an acceptable method of providing a self-locking feature.
5. All-thread thrust restraint rod diameter provides freedom of movement through all bolt holes to allow unrestricted maximum adjustment of equipment connection fittings to accommodate piping misalignment without transmitting any shear to the thrust rods and also to permit full development of thrust restraint at all thrust restraint rod tension take-ups.
6. Design equipment connection fittings per the requirements of AWWA C219.
7. Provide ASTM A193 grade B7, B8, or B8M thrust rods, ASTM A194 grade 2H, 8, or 8M nuts, with matching washers and lock washers to develop full rated piping system pressure thrust forces. For pump applications, select thrust rod quantities and diameters such that the thrust rod stretch under the piping system's operating pressure does not exceed 2.0 mils.
8. Factory apply dry film molybdenum disulfide anti-galling compound to ends of thrust rods, covering all threads subject to nut travel and tightening.
9. Gaskets:
   a. Flange gaskets: Match gasket material specified for Flange Gaskets in the Piping System Schedule for the associated Process Service.
   b. Follower gaskets: Compression Wedge. Match gasket material specified for Mechanical Coupling Gaskets in the Piping System Schedule for the associated Process Service.
10. Provide schedule 40, ASTM A53, Grade B pipe sleeves with ASTM A536, Grade 65-45-12 or ASTM A36 flange bodies and end rings. Pressure rating of flange adapters meet or exceed the pressure rating of the mating flanges. Coat and line all metal portions of equipment connection fittings, with the exception of 316 stainless steel components, with fusion bonded epoxy conforming to AWWA C550 and NSF 61.

D. Dismantling Joints:
   1. Dismantling joints may be used as takedown couplings in accordance with this Specification.
      a. Dismantling joints: fully restrained double flange fittings consisting of a flange coupling adapter and flanged spool piece that allows for longitudinal adjustment.
      b. Provide thrust restraint by means of all threaded rod spanning between flanges and secured to the flanges with a minimum of two flange bolts.
      c. Design Dismantling Joints in accordance with AWWA C219.

d. Provide schedule 40 ASTM A53 Grade B pipe sleeves with ASTM A536 Grade 65-45-12 or ASTM A36 flange bodies and end rings. The pressure ratings of the flange adapters are to meet or exceed the pressure rating of the mating flanges. Coat and line all metal portions of the fittings, with the exception of 316 stainless steel components, with fusion bonded epoxy conforming to AWWA C550 and NSF 61.

e. Candidate manufacturers:

1) Romac DJ-400
2) Smith Blair 975
3) Crane-Viking Johnson Dismantling Joint
4) Approved equal

E. Force Balanced Double Ball Expansion Joints

1. Install double ball expansion joints in the locations specified on the Drawings.
2. Provide foundry certification of material upon request. Materials as follows:
   a. Ductile iron joints conforming to the material requirements of ASTM A536 and AWWA C153.
   b. Type 410 stainless steel lock rings.
   c. EPDM molded watertight construction for ring gasket, casing, ball and cover.
3. Pressure test each expansion joint prior to shipment to a minimum of 250 PSI.
4. Flexible expansion joints consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint, providing a minimum deflection of: 25 degrees per ball for 4-inch through 8-inch expansion joints; 20 degrees per ball for 10-inch and 12-inch expansion joints, and 15 degrees per ball for 14-inch and larger expansion joints. Two ball and socket joints are required for each Double Ball Expansion Joint.
5. Provide 10 inches minimum axial elongation capability with each single or double ball expansion joint. Furnish additional expansion sections as necessary to provide the specified minimum axial elongation capability.
6. Provide force balanced double ball expansion joint fittings that do not expand or exert an axial thrust under internal water pressure.
7. Line all metal surfaces, including the stainless steel lock rings, with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of AWWA C213. Provide EPDM sealing gaskets. Provide NSF 61 compliant coatings and gaskets.
8. Coat exterior surfaces with a minimum of 6 mils of fusion bonded epoxy conforming to AWWA C116.
9. For buried installations, install polyethylene sleeve per AWWA C105, in accordance with the manufacturer's instructions.
10. Candidate manufacturers:
    a. Romac FJ Restraint
    b. Starflex Series 5000
    c. EBAA Iron, Flex-Tend
    d. Approved equal

2.03 UNIONS

A. 2-inch and Smaller: Ground joint screwed pattern unions.

B. 2 1/2-inch and Larger: Ground joint flange unions.

C. Dielectric Unions: Match the pipe material except bronze may be used with copper piping. Dielectric unions shall be EPCO, Capitol Manufacturing, or approved equal.

2.04 INSULATING FLANGES, COUPLINGS, AND UNIONS

A. Flange Insulating Kits: 2-1/2 inches and larger:
   1. Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts.
   2. In accordance with applicable piping material specified in Piping System Schedules (Section 40 05 02.00 through 40 05 02.99). Provide insulating flange assemblies per ASME B31.9 or B31.1. Flange assembly pressure/temperature rating equal to or greater than pipeline rating.
   3. Galvanically compatible with piping.
   4. Gaskets: Full-face, Type E, with elastomeric sealing element. Sealing element retained in a groove within retainer portion of gasket.
   5. Insulating Sleeves: Full-length fiberglass reinforced epoxy (NEMA G-10 grade).
   6. Insulating Washers: Fiberglass reinforced epoxy (NEMA G-10 grade).
   7. Steel Washers: Plated, hot-rolled steel, 1/8 inch thick.
   8. Manufacturers:
      a. Pipeline Seal and Insulator, Houston, TX
      b. Advance Products and Systems, Lafayette, LA
      c. Approved equal

B. Insulating Sleeve Couplings:
   1. Rockwell Type 416.
   2. Dresser Style 39.
   3. Approved equal.

C. Flexible Insulated Couplings:
   1. Dresser; STAB-39.
   2. Baker Coupling Company, Inc.; Series 216.
   3. Approved equal

D. Insulating Unions: Union Type, 2 inches and Smaller:
   1. Screwed or solder-joint.
   2. O-ring sealed with molded and bonded insulation to body.
   3. O-ring sealed with molded and bonded insulating bushing to union body, as manufactured by Central Plastics Co., Shawnee, OK.
   4. Approved equal

2.05 COATINGS

A. Field coat mechanical couplings in Buried exposure areas with System M-1 as specified in Section 09 90 00 – Painting and Coating.

B. Field coat mechanical couplings in Indoor Dry, Indoor Wet, Outdoor, Submerged, Chemical Corrosive, Headspace, and Process Corrosive exposure areas as scheduled in Section 09 90 05.

PART 3 EXECUTION

3.01 FLEXIBILITY

A. Unless otherwise specified, pipe passing from concrete to earth shall be provided with two pipe couplings or flexible joints (or a double ball expansion joint) as specified on the Drawings. Locate pipe couplings within 24 inches of the structure for 2-inch through 6-inch diameter pipe; within 40 inches of the structure for 8-inch through 24-inch pipe; and within one and one-half pipe diameters of the structure for pipe larger than 24-inch. Where required for resistance to pressure, restrain mechanical couplings in accordance with Chapter 13 of AWWA M11, including Tables 13-4, 13-5 and 13-5A, and Figure 13-20.

B. Install Double Ball Expansion Joints with ¼ inch elongation/extension of the minimum axial elongation capability specified in this Section.

3.02 DIELECTRIC CONNECTIONS

A. Provide an insulating section of rubber or plastic pipe where a copper pipe is connected to steel or cast iron pipe. The insulating section shall have a minimum length of 12 pipe diameters.

B. Dielectric unions as specified in this Section may be used instead of the specified insulating sections.

END OF SECTION

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SECTION 40 05 06.13

JOINT GASKETS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies rubber gaskets for push-on compression type joints used with fabricated steel pipe, steel pipe, reinforced concrete pipe, concrete cylinder pipe, and cement mortar lined and coated steel pipe.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reence	Title
ASTM D395	Rubber Property--Compression Set, Test for
ASTM D412	Rubber Properties in Tension, Test for
ASTM D471	Rubber Property--Effect of Liquids, Test for
ASTM D573	Rubber--Deterioration in an Air Oven, Test for
ASTM D1149	Rubber Deterioration--Surface Ozone Cracking in a Chamber (Flat Specimens), Test for
ASTM D2240	Rubber Property--Durometer Hardness, Test for

B. Testing:

1. Certified copies of test reports indicating that the gasket material has been tested and that the results of the tests comply with the requirements specified in paragraph 2.02 shall be provided as product data.

PART 2 PRODUCTS

2.01 MATERIALS

A. Gasket stock shall be a synthetic rubber compound in which the elastomer is neoprene unless otherwise defined in the pipe schedule. The compound shall contain no less than 50 percent by volume neoprene and shall be free from factice, reclaimed rubber and other deleterious substances.

B. Gaskets materials shall be certified for use in drinking water in accordance with NSF/ANSI 61.

2.02 PHYSICAL REQUIREMENTS

A. The compound shall meet the following physical requirements when tested in accordance with the specified ASTM standards.

B. Tensile (ASTM D412):
   1. The tensile strength shall be 1500 psi minimum and the ultimate elongation shall be 350 percent minimum.

C. Hardness (ASTM D2240, TYPE A DUROMETER):
   1. The compound shall have a hardness in the range of 35 to 50 for concrete spigots and 50 to 65 for steel spigots.

D. Compression Set (ASTM D395):
   1. The compression set shall not exceed 20 percent when compressed for 22 hours at 70 degrees C.
   2. The test specimens shall be circular discs cut from the gaskets. Test specimens shall be 0.500 ($\pm$ 0.005 - 0.025) inches in height. The diameter of the test specimen shall be that of the gasket but not to exceed 1.129 $\pm$ 0.010 inches in diameter.

E. Aging (ASTM D573):
   1. The test specimen deterioration shall be less than 20 percent reduction in tensile strength, 40 percent reduction in ultimate elongation, and 15 points increase in hardness.

F. Effect Of Liquids (ASTM D471):
   1. The maximum volume change in oil and in water shall be as follows:
      a. Oil: 100 percent in ASTM oil No. 3.
      b. Water: 15 percent.
   2. The test specimens shall have a thickness of 0.080 $\pm$0.005 inches and shall be circular discs cut from the gasket.

G. Ozone Cracking (ASTM D1149):
   1. The test specimen shall be a gasket loop mounted to give at least 20 percent elongation. There shall be no cracking visible at two times magnification of the gasket after 100 hours exposure to 1 mg/l ozone at 40 degrees C.

2.03 PRODUCT DATA

A. In accordance with Section 01 33 00, the Contractor shall provide certified copies of test reports specified in paragraph 1.02 Testing.

PART 3 EXECUTION

3.01 INSTALLATION

A. The gaskets shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

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SECTION 40 05 06.16

PIPING CONNECTIONS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies the following methods of connecting metallic piping: flanges, threading, mechanical couplings, equipment connection fittings, dielectric unions, and welding.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI Bl.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI Bl.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B18.2.1	Square and Hex Bolts and Screws Inch Series
ANSI B18.2.2	Square and Hex Nuts (Inch Series)
ANSI B31.1	Power Piping
ANSI B31.3	Chemical Plant and Petroleum Refinery Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators Qualifications
ASTM B98	Copper-Silicon Alloy Rod, Bar and Shapes
ASTM F37	Standard Test Methods for Sealability of Gasket Materials
ASTM F104	Standard Classification System for Nonmetallic Gasket Materials
ASTM F152	Standard Test Methods for Tension Testing of Nonmetallic Gasket Materials
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Service-Size 4 in. through 144 in.

Reference	Title
AWWA C219	Bolted, Sleeve-Type Couplings for Plain-End Pipe
AWWA C550	Protective Epoxy Coatings for Valves and Hydrants
AWWA C606	Grooved and Shouldered Joints
AWWA M11	Steel Pipe-A Guide for Design and Installation
NSF 61	Drinking Water System Components - Health Effects

1.03 SUBMITTALS

A. In addition to the material listed in the detailed specification, the following submittals shall be provided in accordance with Section 01 33 00:
   1. For Equipment Connection Fittings used in pumping applications submit thrust rod stretch calculations in accordance with paragraph 2.02 Equipment Connection Fittings. and dimensional layout data.

PART 2 PRODUCTS

2.01 FLANGE ASSEMBLIES

A. Flanges:
   1. General: Flanges shall either be flat flanges or convoluted ring flanges as specified in the following paragraphs.
   2. Flat Flanges: Cast iron flanges shall be faced in accordance with ANSI B16.1. Where companion flanges are used, the flanges on pipe shall be refaced to be flush with the companion flange face. Class 150 and Class 300 forged steel flanges shall be raised face conforming to ANSI B16.5. Lightweight slip-on flanges shall be plain face conforming to AWWA C207, Class B and ANSI B16.5. Unless otherwise specified, steel flanges shall be ANSI B16.5, Class 150 or AWWA C207, Class D. Class E AWWA flanges shall be provided where test pressure exceeds 175 psi. Plain faced flanges shall not be bolted to raised face flanges.
   3. Convoluted Ring Flanges: Convoluted ring flanges shall be ductile iron, forged steel or cast stainless steel, designed to bear on hubs welded to the pipe and shall be as manufactured by Improved Piping Products. The Construction Manager knows of no equal. The flange joints shall be rated for not less than 150 percent of the test pressures listed in Section 40 05 01 and shall conform to the requirements of ANSI B 16.5 and AWWA C207. The flange manufacturer shall be prepared to demonstrate, by certified pressure test that the flanges will meet these requirements.

B. Gaskets:
   1. Gasket material shall be as specified in paragraph 2.03.
   2. Gaskets for plain faced flanges shall be the full face type. Thickness shall be 1/16 inch for pipe 10 inches and less in diameter and 1/8 inch for pipe 12 inches and larger in diameter. Unless otherwise specified, gaskets for raised face flanges shall match the raised face and shall be 1/16 inch thick for pipe 3-1/2 inches and less in diameter and 1/8 inch thick for pipe 4 inches and larger.

C. Bolts:

1. Flange assembly bolts shall be ANSI B18.2.1 standard square or hexagon head bolts with ANSI B18.2.2 standard hexagon nuts. Threads shall be ANSI Bl.1, standard coarse thread series; bolts shall be Class 2A, nuts shall be Class 2B. Bolt length shall conform to ANSI B16.5.
2. Unless otherwise specified, bolts shall be carbon steel machined bolts with hot pressed hexagon nuts. Bolts for submerged service shall be made of Type 316 stainless steel in conformance with ASTM F593, marking F593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04 or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

2.02 MECHANICAL COUPLINGS

A. Sleeve-Type Couplings:

1. Unless otherwise specified, sleeve-type mechanical pipe couplings shall be Smith-Blair Type 411, Dresser Style 38, or equal, with the stop removed from the middle ring. Reducing couplings shall be Smith-Blair Type 415, Dresser Style 62, or equal. Sleeve-type flanged coupling adapters shall be Smith-Blair Type 913, Dresser Style 128, or equal. Insulating couplings shall be Smith-Blair Type 416, Dresser Style 39, or equal.
2. Bolts for submerged service shall be made of Type 316 stainless steel in conformance with ASTM F593, markingF593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04, or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.
3. Gaskets shall be as specified in paragraph 2.03 and AWWA C111.

B. Plain End Couplings:

1. Plain end pipe couplings for pipe sizes 6 inches and smaller shall be Gustin-Bacon 200, Victaulic Style 99, or equal for Schedule 80 pipe and Gustin-Bacon 205, Victaulic Style 90, or equal for lighter weight pipe. Plain end couplings for pipe sizes 8 inches and larger shall be Gustin-Bacon 200, Victaulic Style 99, or equal. Unless otherwise specified, bolts and nuts shall comply with AWWA C606.
2. Gaskets shall be as specified in paragraph 2.03 and AWWA C606.

C. Grooved End Couplings:

1. Grooved end flexible-type couplings shall be Gustin-Bacon 100, Victaulic Style 77, or equal. Grooved end rigid-type couplings shall be Gustin-Bacon 120 Rigi-Grip, Victaulic Style 07 Zero-Flex, or equal. Flexible-type couplings shall be used for all piping greater than 12 inches in diameter; for pipe 12 inches in diameter and less in rack-mounted tunnel piping applications; and for grooved joints adjacent to pump or blower suction and discharge where grooved couplings are used for noise and vibration control. All other applications for piping 12 inches in diameter and less shall utilize rigid-type couplings. Grooved end flanged coupling adapters shall be either Gustin-Bacon 154, Victaulic Style 741, or equal. Snap-joint grooved end couplings shall be Gustin-Bacon 115, Victaulic Style 78, or equal. Cut grooves are not permitted on fabricated or light wall pipe.
2. Unless otherwise specified, bolts and nuts shall comply with AWWA C606. Bolts for submerged service shall be Type 316 stainless steel in conformance with ASTM F593, marking F593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04 or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.
3. Gaskets shall be as specified in paragraph 2.03 and AWWA C 606.

D. Equipment Connection Fittings

1. Equipment connection fittings shall provide both lateral and angular misalignment adjustment between equipment connection flanges and the connection to field piping systems by providing individually adjustable flexible joints at each connection. In addition, equipment connection fittings shall provide full pressure thrust restraint between the field piping connection and equipment connection flanges.
2. Equipment connection fittings shall consist of two flanged coupling adapters, a plain end section of pipe and thrust restraint rods and associated fittings designed to transmit thrust without transmitting shear to the thrust restraint rods and without compromising provisions for accommodating angular and parallel misalignment. Materials and features shall conform to the requirements established in this paragraph. Standard “dismantling joints” incorporate only one flanged coupling adapter and are not acceptable substitutes. Equipment connection fittings shall be Romac ECF Series, or Baker Coupling Company, Los Angeles or equal, modified as specified to provide the required features.

3. Equipment connection fittings shall each consist of a single sleeve of plain end piping conforming to the requirements of the specified piping system of sufficient length to span the gap between the connection at the equipment and the connection at the field piping with gasketed flange adapters at each end. Thrust restraint shall be provided by means of all threaded rod spanning between flanges and male rod nuts and female washers that are rounded to provide a ball-joint type self-aligning feature. All threaded restraint rod shall project through flange and mating flange coupling adapter bolt holes or through holes in restraint lug plates that extend above the flanges and are secured to the flanges with a minimum of two flange bolts. Where the all-threaded rods project through flange bolt holes, ball joint type nut and washer combinations and lock washers shall be provided at each face, each end. Where restraint lug plates are employed, ball joint type nuts and washers shall be provided only on the outside faces of the plates and the nuts shall have a self-locking feature that prevents nut movement due to vibration or other operational or environmental causes. Double nutting with non-locking nuts shall not be an acceptable method of providing the self-locking feature. Thrust rod diameter and material shall be selected to provide sufficient freedom of movement through all bolt holes to allow unrestricted maximum adjustment of equipment connection fittings to accommodate piping misalignment without transmitting any shear to the thrust rods and also to permit full development of thrust restraint at all thrust rod tension take-ups. Design of equipment connection fittings shall conform to AWWA C219.
4. Thrust rods, restraint lug plates, nuts, washers and lock washers shall be Type 316 stainless steel, all selected to develop full rated piping system pressure thrust forces. Equipment connection fittings for pump applications shall have thrust rod number and diameter selected such that thrust rod stretch under piping system operating pressure does not exceed 2 mils. Calculations shall be submitted. Dry film molybdenum di-sulfide anti-galling compound shall be factory applied to ends of thrust rods, covering all threads subject to nut travel and tightening. Gaskets shall be as specified in paragraph 2.03. Flange gaskets shall be full face type. Follower gaskets shall be compression wedge type.
5. Sleeves shall be carbon steel or as specified for the specific piping system. Pressure rating of flange adapters shall equal or exceed the pressure rating of mating flanges. All metal portions of equipment connection fittings, with the exception of 316 stainless steel components, shall be coated and lined with fusion bonded epoxy conforming to AWWA C550 and NSF 61.

E. Dismantling Joints:
1. Dismantling joints may be used as takedown couplings in accordance with paragraph 3.03. Dismantling joints shall fully restrained double flange fittings consisting of a flange coupling adapter and flanged spool piece that allows for longitudinal adjustment. Thrust restraint shall be provided by means of all threaded rod spanning between flanges and secured to the flanges with a minimum of two flange bolts. Design of equipment connection fittings shall conform to AWWA C219. Sleeves shall be carbon steel or as specified for the specific piping system. Pressure rating of flange adapters shall equal or exceed the pressure rating of mating flanges. All metal portions of equipment connection fittings, with the exception of 316 stainless steel components, shall be coated and lined with fusion bonded epoxy conforming to AWWA C550 and NSF 61. Dismantling joints shall be Romac DJ-400, Smith Blair 975, or Crane-Viking Johnson Dismantling Joint.

F. Sleeve Band Couplings:

1. Sleeve band couplings shall be Victaulic Depend-O-Lock. Unless otherwise noted, couplings for liquid service shall be Model F x F Type 2 fully restrained, shouldered high deflection couplings with standard width band. Couplings shall comply with AWWA C-219. Couplings for use with air systems shall be Airmaster restrained Depend-O-Lock couplings in conformance with AWWA C-606. Sleeve band couplings are acceptable wherever sleeve type couplings are used (paragraph 2.02 Sleeve Type Coupling).

G. Flexijoint:

1. Where specified Flexijoint couplings shall be Flanged Romac Flexijoint couplings. The Flexijoint is a flexible, ductile iron joint that can accommodate expansion, contraction, rotation and bending and is rated at 350 psi working pressure. The joint can accommodate 15 to 20 degree deflection depending on size. Body shall be ductile iron, lock rings Type 410 stainless steel, and ring gasket, casing, ball and cover shall be EPDM molded watertight construction. All metal portions of Flexijoint coupling including the stainless steel lock rings shall be coated and lined with fusion bonded epoxy conforming to AWWA C550 and NSF 61. For buried installations, install with polyethylene baggy cover in accordance with the manufacturer's instructions.

2.03 GASKETS

A. Gaskets designated in Section 40 05 01 shall be as follows:

1. EPDM: ethylene-propylene-diene-terpolymer.
2. Neoprene: neoprene (black)
3. Nitrile: nitrile (Buna N).
4. SBR : Styrene-butadiene (red)
5. Natural Rubber : Natural Rubber
6. Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder; ASTM F104 (F712400), 2500 psi (ASTM F152), 0.2 ML/HR LEAKAGE FUEL A (ASTM F37).
7. Compressed gasketing consisting of organic fibers (Kevlar) and SBR binder; ASTM F104 (F712400), 2500 PSI (ASTM F152), 0.1 ml/hr leakage Fuel A (ASTM F37).
8. Gylon gasketing, Garlock Style 3500, 2000 psi (ASTM F152), 0.22 ml/hr Fuel A (ASTM F37).
9. Gylon gasketing, Garlock Style 3510, 2000 psi (ASTM F152), 0.04 ml/hr Fuel A (ASTM F37).
10. Gylon gasketing, Garlock Style 3504, 2000 psi (ASTM F152), 0.12 ml/hr Fuel A (ASTM F37).
11. CPE: Chlorinated Polyethylene
12. TFE: noncreeping tetrafluoroethylene (TFE) with insert filler.
13. Spiral Wound: per ASME B16.20, rated to 1200 degrees Fahrenheit, Flexitallic SS316L or approved equal.
14. PTFE bonded EPDM: PTFE bonded to EPDM in full-face gasket having concentric-convex molded rings; Garlock Stress Saver 370 or equal.
15. Viton FKM – Fluoroelastomer, 75 Durometer.

2.04 THREAD

A. Pipe thread dimensions and size limits shall conform to ANSI Bl.20.1.

2.05 DIELECTRIC UNIONS

A. Dielectric unions shall be EPCO, Capitol Manufacturing, or equal.

2.06 COATINGS

A. Unless otherwise specified, flange assemblies and mechanical type couplings for buried installation shall be field coated with System M-1 as specified in Section 09 90 00.

2.07 PRODUCT DATA

A. In accordance with Section 01 33 00, the Contractor shall provide for each welder, a welder qualification certificate indicating the welder is certified for pipe welding in accordance with ASME Boiler and Pressure Vessel, Section IX. Each welder's certificate shall be provided to the Construction Manager prior to that welder working on the job.

PART 3 EXECUTION

3.01 PIPE CUTTING, THREADING AND JOINTING

A. Pipe cutting, threading and jointing shall conform to the requirements of ANSI B31.1.

3.02 PIPE WELDING

A. Unless otherwise noted, Pipe shall be welded by ASME-certified welders using shielded metal arc, gas metal arc, gas tungsten arc, or submerged arc welding methods unless specified otherwise in Section 40 05 23 or Section 40 05 24.

3.03 TAKEDOWN COUPLINGS

A. Takedown couplings shall be screw unions, flanged or grooved end mechanical coupling type joints and shall be provided as specified. Flanged or grooved end joints shall be employed on pipelines 2-1/2 inches in diameter and larger. Where piping passes through walls, takedown couplings shall be provided within 3 feet of the wall, unless specified otherwise.

B. A union or flanged connection shall be provided within 2 feet of each threaded end valve.

3.04 FLEXIBILITY

A. Unless otherwise specified, piping passing from concrete to earth shall be provided with two pipe couplings or flexible joints (or a single Flexijoint) as specified on the buried pipe within 2 feet of the structure for 2-inch through 6-inch diameter pipe; within 3 feet of the structure for 8-inch through 24-inch diameter pipe; and within one and one-half pipe diameters of the structure for larger pipe. Where required for resistance to pressure, mechanical couplings shall be restrained in accordance with Chapter 13 of AWWA M11, including Tables 13-4, 13-5 and 13-5A, and Figure 13-20.

3.05 DIELECTRIC CONNECTIONS

A. Where a copper pipe is connected to steel or cast iron pipe, an insulating section of rubber or plastic pipe shall be provided. The insulating section shall have a minimum length of 12 pipe diameters. Dielectric unions as specified in paragraph 2.05 may be used instead of the specified insulating sections. Where copper pipe is supported from hangers, it shall be insulated from the hangers, or copper-plated hangers shall be used.

3.06 EQUIPMENT CONNECTION FITTINGS

A. Where shown, equipment connection fittings shall be provided between field piping systems and equipment inlet and outlet connections.

END OF SECTION

SECTION 40 05 06.23

EXPANSION JOINTS AND FLEXIBLE METAL HOSE

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies piping expansion joints and flexible metal hose.

B. Provide professional engineering services for a piping system dsign engineer (hereinafter the “Design Professional”) as specified in Section 40 05 01, this Section, and related sections.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 66 00 – Product Storage and Handling Requirements
   3. Section 40 05 01 – Piping Systems
   4. Section 40 05 02 – Piping System Schedules
   5. Section 40 05 06 – Specialty Couplings and Adapters for Process Piping
   6. Section 40 05 07 – Hangers and Supports for Process Piping
   7. Section 40 05 07.13 – Seismic Restraints for Piping
   8. Section 40 05 07.16 – Expansion Control for Piping

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
EJMA STDS	Standards of Expansion Joint Manufacturers' Association, Edition No. 5

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. Expansion Joint: Any device used to absorb dimensional changes and/or misalignment.
   2. Pipe Section: the portion of pipe between two anchors.
   3. Lateral Direction: Direction perpendicular to the pipe axis.
   4. Longitudinal Direction: Direction parallel to the pipe axis.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordination required with the design of piping systems, piping supports (hangers, guides, anchors, structural attachments, etc.), and expansion control and seismic restraints.
   2. Select and install expansion joints and flexible metal hose in conformance with the expansion control system designed by the Design Professional, retained under the requirements of Section 40 05 01, and the criteria specified herein. This requirement, however, shall not be construed as relieving the Contractor of responsibility for this portion of the work.
   3. Refer to Section 40 05 01 for additional coordination requirements.

1.06 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with addenda updates, and all referenced sections with each paragraph check marked to show specification compliance or marked to show deviations.
   3. Design and construction details of formed metal bellows type expansion joints.
   4. Percent enlongation over range of design temperatures.
   5. Pressure thrust force and spring rate data for formed metal bellows expansion joints.
   6. Materials, design and construction, and temperature and pressure rating for elastomer and fabric expansion joints.
   7. Details for the installation of all expansion joints.
   8. Listing of all flexible metal hose applications.

1.07 QUALITY ASSURANCE

A. Refer to Section 40 05 01 for additional quality assurance requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Additional requirements: 40 05 01.

PART 2 PRODUCTS

2.01 PERFORMANCE / DESIGN CRITERIA

A. General:
   1. All expansion joints and flexible hose materials shall be new, free from defects and conforming to the requirements and standards specified in this Section.
   2. Furnish expansion joints and flexible metal hose as specified in Part 4 of this specification.

3. Provide control units (tie rods or restraints) to prevent excessive axial elongation and to accept the pressure thrust in the piping system. Number and sizes of control rods or restraints shall be as determined by the manufacturer.

B. Expansion Joints:
   1. Expansion joints shall be designed in accordance with EJMA Standards for pressure, temperature and service as specified in the Piping System Schedules (Section 40 05 02.00 through 40 05 02.99) without crimping of corrugations.
   2. Corrugated type expansion joints shall be suitable for a minimum of 10,000 pressure, temperature and deflection cycles (non-concurrent).
   3. Supply bellows type expansion joints suitable for a minimum of 10,000 pressure, temperature and deflection cycles (non-concurrent).

C. Flexible Metal Hose:
   1. Flexible metal hose shall be suitable for a line pressure equal to the test pressure listed in the Piping System Schedules (Section 40 05 02.00 through 40 05 02.99).
   2. Live lengths for flexible metal hose shall be based on service as specified and a design life of 1,000,000 full displacement cycles.

2.02 EXPANSION JOINTS

A. Metal Construction
   1. Formed Bellows Type
      a. Medium Temperature:
         1) Formed bellows-type expansion joints for temperatures up to 800 degrees F shall have 300 series stainless steel multi-ply bellows rated for the specified design temperature and pressure.
         2) Test pressures are specified in the Piping System Schedules (Section 40 05 02.00 through 40 05 02.99). Each expansion joint shall be factory tested at the test pressure.
         3) Ductwork expansion joints may be rated at less than 50 psig but must be rated equal to the design pressure specified and, in no case, less than 2 psig.
         4) Expansion joint design shall be determined by the amount and kind of movement specified (axial, lateral, angular). Unless otherwise specified, end connections shall be flanged.
         5) Acceptable manufacturers: Formed bellows type expansion joints shall be as manufactured by U.S. Bellows, Senior Flexonics, Inc., Hyspan Precision Products, Inc., American BOA Inc. or approved equal.
      b. High Temperature:
         1) Engine and gas turbine exhaust expansion joints for temperatures up to 1300 degrees F shall be the multi-ply bellows type designed for 15 psig. Bellows shall be constructed of 300 series stainless steel.
         2) Unless otherwise specified, end connections shall be either the fixed flange or Vanstone flange configuration. Flange material shall be carbon steel for temperatures up to 1000 degrees F and stainless steel for temperatures 1000-1300 degrees F. Vanstone materials and flow liners, where specified, shall be the same as bellows material.

3) Exhaust expansion joints shall be Flexonics DEX Series, Hyspan Series 2500, American BOA Series 025E, or equal.

2. Expansion Compensator Type
   a. Steel Expansion Compensator:
      1) Compensators shall have 2-ply stainless steel bellows and carbon steel shroud and end fittings. Compensators shall be rated for 175 psi maximum working pressure and 750 degrees F.
      2) Steel expansion compensator type expansion joints shall be Flexonics Model H Expansion Compensator, Hyspan Series 8500, Keflex 7Q, or equal.
   b. Bronze Expansion Compensator:
      1) Compensators shall have multi-ply phosphor bronze or stainless steel bellows and copper tube end fittings. Compensators shall be rated for 150 psi maximum working pressure and 400 degrees F.
      2) Bronze expansion compensator type expansion joints shall be Flexonics Model HB Expansion Compensator, Hyspan Series 8500, Keflex 7Q, American BOA Inc., or equal.

B. Elastomer and Fabric Construction
   1. General Requirements:
      a. Standard spool arch type or the precision molded spherical design type as specified.
      b. Single arch and sphere type expansion joints, unless otherwise indicated, have 150-mm face-to-face dimension for pipe up to 200 and 200-mm face-to-face dimension for pipe 250 and 300. For use with larger diameters, Contractor must obtain approval from the Owner's Representative.
      c. Cover elastomer constructed of chlorobutyl, neoprene, or EPDM.
      d. Tube elastomer constructed of chlorobutyl or EPDM for temperatures between 80 and 115 degrees C. Neoprene or Buna N liners are acceptable for temperatures up to 80 degrees C.
   2. Spool Type:
      a. Resilient arch type and standard or tapered as specified. Unless otherwise specified, all tapered connectors shall be eccentric.
      b. Constructed of multiple plies of woven fabric impregnated with elastomer and reinforced with steel rings or wire embedded in the body.
      c. Provide retaining or backup rings for standard arch type expansion joints suitable for the specified temperature and pressure. Rings shall be 10-mm-thick steel, split, either galvanized or zinc shield coated.
      d. Use filled arch type expansion joints on all piping systems carrying fluids containing solids.
      e. Acceptable manufacturers for single, multiple, or filled arch: Unisource Series 1200, Garlock Style 204, Mercer Style 500, or approved equal.
      f. Acceptable manufacturers for high pressure couplings suitable for 240 degree F operating temperatures: Unisource Series 1500, Mercer Style 510, Garlock Style 204-HP, General Style 1015, or approved equal.
   3. Spherical Molded Type:

a. Spherical molded type expansion joints shall be precision molded of multiple plys of nylon tire cord fabric and elastomer suitable for specified temperature and pressure.
b. Spherical molded type expansion joints shall have steel or ductile iron floating flanges, and no metal parts shall come in contact with the fluid.
c. Acceptable manufacturers for single sphere molded connectors shall be Mason Type MFNC, Mercer Type 5500, Goodall Type E-611, General Type 1010, Garlock Style 8100, or approved equal.
d. Provide double sphere or triple sphere connectors where required to provide for the specified movement.

C. Polymer Expansion Joints:
1. PVC/CPVC Construction:
a. Provide expansion joints for PVC or CPVC piping that are EPDM elastomer flexible double-bellows. Attach expansion joints to pipe using union-type couplings.
b. PVC/CPVC acceptable manufacturers: Spears; Flexicraft; Approved Equal.
2. TFE/PTFE Construction:
a. Provide PTFE expansion joint with external stainless steel reinforcing rings, limit rods, and flanges. Expansion joints shall be designed to the FSA 0012 design standard. Use polymer-coated tie rods or grommets between the tie rods and flanges; metal-to-metal contact between the rods and flanges are not acceptable. Flanges must be completely isolated from the chemical by the molded PTFE bellows.
b. Provide safety shields over PTFE joints and connections.
c. Molded PTFE expansion joints acceptable manufacturers: Garlock Style 214/215, Crane Resistoflex R-series, Flexicraft Teflex Series, or approved equal.

2.03 FLEXIBLE HOSE

A. Flexible Metal Hose:
1. Unless otherwise specified, flexible metal hose shall be corrugated type 321 stainless steel with stainless steel fittings and shall be provided with stainless steel single braid.
2. Attach end connections by helical crest welding.
3. Provide bronze flexible metal hose for copper and brass systems.
4. Acceptable manufacturers: American BOA Series B, Flexonics, Unisource, Metraflex, or approved equal.

B. Flexible teflon hose
1. Provide teflon flexible connectors consiting of molded teflon bellows and 150-pound ductile iron flanges. The flanges shall be completely isolated from the chemical by the molded teflon bellows.
2. Provide integral steel limit bolts and Monel reinforcing rings on the connectors. Provide connectors with nonasbestos gaskets. The connectors shall allow for an axial transverse movement of at least 1/2-inch, and an offset of at least 3/8-inch. The connectors shall be rated for a pressure of 130 psi, at a temperature of 70 degrees F.

3. Acceptable manufacturers: Jackson Industrial, Metraflex Teflon Expansion Joint, Garlock, modified as necessary to provide the specified features, or approved equal.

2.04 FLEXIBLE METAL HOSE LOOP

A. Flexible metal hose loops consist of two parallel sections of corrugated stainless steel metal hose and single braid with 180 degree return bend, flanged inlet and outlet connections.

B. Furnish flexible metal hose loops that provide the amount and kind of movement (axial, lateral, angular, torsional) scheduled in this Section. Provide supports at 180 degree return bend per manufacturer's recommendations.

C. For loops using hanger supports, provide seismic break-away coupling to allow separation during seismic event.

D. Acceptable Manufacturers: Metraflex; Flexicraft; Anvil International; Approved Equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Located expansion joints as specified. Location and number of guides shall be determined from EJMA Standards.

B. For piping services operating at less than 170 degree F, do not install expansion joints during times of extreme temperature or in a fully compressed or fully expanded condition.

C. For piping services operating at over 170 degree F, install expansion joints at percent elongation corresponding to installation temperature as a percent of maximum operating temperature.

D. Unless otherwise specified, expansion joints 4 inches and larger shall be furnished with control rods.

3.02 ALIGNMENT

A. Align piping systems prior to installation of expansion joints.

B. Do not use expansion joints to correct piping misalignment during installations.

C. Install expansion joints normally preset at the factory for rated axial compression and expansion in this preset condition.

D. Set control units/tie rods/restraints after all pressure testing of the piping system is complete.

PART 4 SCHEDULE

4.01 EXPANSION JOINT AND CONNECTOR SCHEDULE

A. Expansion joints and/or flexible metal hose connectors provided for specific equipment items or piping systems are specified on the following schedule. The location of piping system expansion joints and design criteria, including temperature, pressure and movement for each joint, are specified and/or shown on the drawings.

B. Expansion joints and connectors shall be provided in accordance with the following table. If a particular joint or connector is shown or specified for a given location, that more detailed selection shall apply.

Expansion Joint and Connector Schedule

Type of Expansion Joint/Connector	Type of Service/Use
Formed Bellows Type [Paragraph 2.01.A.1]	Boiler exhaust, hot water, high pressure air, and gas and steel lines subjected to ambient temperature differentials sufficient to require expansion joints.
Expansion Compensator Type [paragraph 2.01.A.2]	Same type service/use as for "Formed Metal Bellows type expansion joint" except size of piping is limited to 3 inch diameter or less.
Elastomer Spool Arch (Paragraph 2.01.B.2.)	Blower connectors and expansion joints for piping 14 inch diameter and larger.
Elastomer Spherical Molded [Paragraph 2.01.B.3]	Blower connectors and expansion joints for piping 12 inch diameter and less [Excludes steam and chemical services]
PVC [Paragraph 2.01.C.1]	PVC piping.
Teflon [Paragraph 2.01.C.2]	RTRP (FRP) piping.
Stainless Steel Braided Hose [Paragraph 2.03.A]	Stainless Steel and Carbon Steel Tank Connections [Exlcudes Chemical Services]
Bronze Braided Hose [Paragraph 2.03.A]	Air compressor discharge and pump connectors for copper lines.
Teflon Flexible Connector [Paragraph 2.03]	Connection of PVC piping to chemical storage tanks.

END OF SECTION

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SECTION 40 05 07

HANGERS AND SUPPORTS FOR PROCESS PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies hangers and supports for all exposed piping systems specified in Section 40 05 01. This section does not include pipe supports for fire sprinkler systems or seismic restraints.

B. Scope Of Contractor Design: The Contractor shall provide the services of a "Design Professional" as specified in Section 40 05 01 to conduct all necessary piping and support design for exposed piping.

1. Whether a design or general arrangement is shown or not, Contractor's Design Professional shall design all pipe supports, anchorage, restraints and expansion control, as specified. Where a conflict arises, Contractor's Design Professional shall present any conflict to Construction Manager for resolution.
2. The Design Professional's work shall incorporate design criteria and other conditions as specified herein, in related sections and as shown on the drawings.
3. Additional requirements are specified in related sections.
4. Bidding: For purposes of bidding supports within Design Professional's Scope of Responsibility, Contractor may use the support and seismic restraint tables presented in Appendix A of this Section and information shown on the Drawings.
    a. Additional supports are required for concentrated loads, changes in direction and disassembly.
    b. Support frequency shall be determined based upon hanger load capacity, with minimum indicated factor of safety specified. Rod hanger support frequency indicated in Table A (Appendix A) shall not be represented as being sufficient to address seismic loads.
    c. Notwithstanding the Mechanical Standard Details and direction as shown on the Drawings, the full scope of supports, specified and shown, including those within the Design Professional's Scope of Responsibility is required work and differences between bid quantities and actual requirements will not be considered as extra work subject to adjustment by change order.

C. Scope Of Work By Design Engineer: Design Engineer has undertaken design details for supports and anchors for: selected discharge and intake manifolds; selected special installation requirements; and, selected piping 24-inches and larger. Contractor's Design Professional shall incorporate these features into the Contractor's design.

1. Where shown, Design Engineer has also provided guidance in the form of general arrangements that may include specific types of supports or anchorage details. In addition, allowable anchor points and load capacities for potential support structures are shown or otherwise described herein.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 61 45 – Area Exposure Designations
   3. Section 01 66 00 – Product Storage and Handling Requirements
   4. Section 01 73 24 – Design Requirements for Non-Structural Components and Non-Building Structures
   5. Section 03 30 00 – Cast-in-Place Concrete
   6. Section 05 05 20 – Anchor Bolts
   7. Section 40 05 01 – Piping Systems
   8. Section 40 05 02 – Piping System Schedules
   9. Section 40 05 07.13 – Seismic Restraints for Piping
   10. Section 40 05 45 – Piping System Identification
   11. Section 40 42 00 – Insulation for Exposed Piping and Equipment

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design - 9th Ed.
FEDSPEC WW-H-171e-78	Hangers and Supports, Pipe
MFMA-2-91	Metal Framing Standards Publication
MSS SP-69-91	Pipe Hangers and Supports - Selection and Application
MSS SP-58-93	Pipe Hangers and Supports - Materials, Design and Manufacture

1.04 DEFINITIONS (NOT USED)

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordination required with the design of piping systems, expansion joints, and expansion control and seismic restraints.
   2. Refer to Section 40 05 01 for additional coordination requirements.
   3. Refer to paragraph 1.09 Hanger and Supports Selection and Design for additional coordation requirements.

1.06 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with addenda updates, and all referenced sections with each paragraph check marked to show specification compliance or marked to show deviations.
   3. Hanger and support locations and components shall be indicated on the piping layout drawings required by Section 40 05 01.

B. Informational Submittals:
   1. Procedures: Section 01 33 00.
   2. Design Professional's reports as specified in paragraph 3.05.

1.07 QUALITY ASSURANCE

A. Refer to Section 40 05 01 for additional quality assurance requirements.

B. Refer to paragraph 1.09 Pipe Hanger and Support Selection and Design for additional quality assurance requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Additional requirements: 40 05 01.

1.09 PIPE HANGER AND SUPPORT SELECTION AND DESIGN

A. Hanger And Support Selection:
   1. The Contractor shall cause the pipe hangers and supports to be designed and selected by the Design Professional retained under the provisions of Section 40 05 01. This provision, however, shall not relieve the Contractor of overall responsibility for this portion of the work. Hanger and support selection shall be based on the following:
      a. The Contractor shall select pipe hangers and supports as specified in the project manual. Selections shall be based upon the pipe support classifications specified in MSS-SP 69, the piping insulation thickness specified in Section 40 42 00, and any special requirements which may be specified in the project manual.
      b. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the type of support to be used at each hanger point.
      c. Where a particular pipe support arrangement is shown, a design incorporating that arrangement shall be used.
      d. Where a particular pipe support design is shown, that design shall be used.
      e. Pipe supports shall be spaced such that pipe span deflections do not exceed 0.1-inch.
      f. Pipe support design shall incorporate applicable criteria of ASME or other recognized standard.

g. The pipe hanger and support system shall be coordinated with the seismic restraint system specified under Section 40 05 07.13.

h. Hangers and supports shall withstand all static and specified dynamic conditions of loading to which the piping and associated equipment may be subjected. As a minimum, consideration shall be given to the following conditions:

1) Weights of pipe, valves, fittings, insulating materials, suspended hanger components, and normal fluid contents.

2) Weight of hydrostatic test fluid or cleaning fluid if normal operating fluid contents are lighter.

3) Reaction forces due to test and operational conditions.

4) Reaction forces due to the operation of safety, relief, or other valves.

5) Wind, snow or ice loadings on outdoor piping.

6) Supports shall be designed to prevent transfer of the weight of piping, valves and piping appurtenances to equipment piping connections. All supports adjacent at equipment connections to piping systems shall have provisions for vertical and horizontal adjustment. Two flexible piping connections not less than one pipe diameter apart shall be provided between piping supports and any equipment piping connection.

i. Hangers and supports shall be sized to fit the outside diameter of pipe, tubing, or, where specified, the outside diameter of insulation.

j. Where negligible movement occurs at hanger locations, rod hangers shall be used for suspended lines, wherever practical. For piping supported from below, bases, brackets or structural cross members shall be used.

k. Hangers for the suspension of size 2 1/2 inches and larger pipe and tubing shall be capable of vertical hanger component adjustment under load.

l. The supporting systems shall provide for and control the free or intended movement of the piping including its movement in relation to that of connected equipment.

m. Where there is horizontal movement at a suspended type hanger location, hanger components shall be selected to allow for swing. The vertical angle of the hanger rod shall not, at any time, exceed 4 degrees.

n. There shall be no contact between a pipe and hanger or support component of dissimilar metals. Prevent contact between dissimilar metals when supporting copper tubing by use of copper-plated, rubber, plastic or vinyl coated, or stainless steel hanger and support components.

o. Stock hanger and support components shall be used wherever practical.

p. Fiberglass framing channel shall be provided where specified.

B. The following structural criteria shall also be applied:

1. Unless otherwise specified, existing pipes and supports shall not be used to support new piping.

2. Unless otherwise specified, pipe support components shall not be attached to pressure vessels.

3. Where critical support load requirements have been identified, limiting structural load requirements are shown.

4. Pipe support hangers, brackets etc. shall be of suitable capacity and shall be appropriate to the individual structural member that is used to support the pipe.

5. The structural integrity of existing and new members shall in no way be impacted by the placement of connections for pipe supports. For example, the tension reinforcement in reinforced concrete members shall not be impacted in any way by the placement of fasteners for pipe supports.
6. Spacing and arrangement of hangers supporting pipe shall be provided in such a manner that the loads from the pipes on existing and new structural members shall be quasi-uniform. These quasi-uniform loads shall not exceed the allowable design loads for mechanical equipment as shown on existing (not necessarily contract) drawings and as listed under Design Live Loads in the General Notes.
7. For new construction, unless otherwise shown, pipe may be supported from nearest structural element (floor, ceiling, or wall). The Design Loads for mechanical equipment, as listed in the General Notes sheet of the Structural drawings shall not be exceeded.
8. The loads and specific attachment requirements for pipe supports on new concrete Tees shall be coordinated with the Tee manufacturer and incorporated into the design of the Tees.
9. Unless otherwise specified, pipe supports from existing Tees or other roof types shall not be constructed without an evaluation of capacity and appropriate design from Contractor's Design Professional.

C. The following, project-specific criterion shall also be applied:
1. The spacing for pipe hangers shall not be less than 5 feet and shall not exceed 375 lbs of load for all existing pre-cast, Double Tee roof elements. For hangers off flanges of existing Tees, a washer shall be provided having minimum dimensions of 1/4 inch thick by 4 inch long and 4 inch wide. The design and projection of those hangers above the roof shall be coordinated with the architectural roofing system.
2. For sodium hydroxide systems, pipe supports shall be 60 percent closer than the maximum spacing indicated for plastic piping for water service.

PART 2 PRODUCTS

2.01 PERFORMANCE/ DESIGN CRITERIA

A. Service Conditions:
1. The hangers and supports specified in this section are provided to resist pipe loads occurring primarily in the downward (gravity) direction. For the purpose of pipe hanger and support selection, this section establishes pipe support classifications based on the operating temperatures of the piping contents. Pipe support classifications are as follows:
   a. Hot Systems
      1) A - 1. 120 degrees F to 450 degrees F
      2) A - 2. 451 degrees F to 750 degrees F
      3) A - 3. Over 750 degrees F
   b. Ambient Systems
      1) B. 60 degrees F to 119 degrees F
   c. Cold Systems
      1) C - 1. 33 degrees F to 59 degrees F
      2) C - 2. -20 degrees F to 32 degrees F

B. Design:
   1. The Contractor shall cause the design of pipe hanger and support systems to be developed in conjunction with preparation of the design seismic restraints and expansion control system by the Design Professional selected in accordance with Section 40 05 07-1.01 and 1.09. The pipe system drawings specified in Section 40 05 07-1.06 shall show the hanger and support locations as well as the details of the seismic restraints and expansion control systems. The pipe hanger and support design drawings and calculations shall be prepared and signed by the design professional and shall bear the Design Professional's registration seal.

2.02 MATERIALS

A. Standard pipe supports and components shall be manufactured by B-Line, Carpenter & Patterson, Kin-Line, Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or equal. Pipe support components shall conform to the requirements of MSS SP-69 and FEDSPEC WW-H-171e.

B. Pipe support materials shall conform to the requirements of MSS SP-58. Metal framing system components shall conform to the metal framing manufacturers' Association Standard MFMA-2.

2.03 CONFIGURATION, COMPONENTS, FEATURES

A. General:
   1. Unless otherwise specified, pipe hangers and supports, structural attachments, fittings and accessories shall be hot-dip or mechanically galvanized after fabrication. Nuts, bolts and washers may be zinc-plated except for those subject to moisture or corrosive atmosphere, as specified in Section 26 05 00-1.05 Corrosive Areas as shown on the drawings, which shall be type FRP or 304 stainless steel.

B. Pipe Hangers And Supports:
   1. Pipe hangers and supports of dissimilar metals than pipe shall be insulated. Pipe hangers and supports shall support pipe in the manner recommended by the pipe manufacturer and/or applicable building or piping codes.

C. Rack And Trapeze Supports:
   1. Unless otherwise specified, trapeze and pipe rack components shall have a minimum steel thickness of 12 gage, with a maximum deflection 1/240 of the span.

D. Structural Attachments:
   1. Type A - Malleable Iron Concrete Insert: Concrete inserts shall be malleable iron and comply with MSS and FEDSPEC Type 18. Grinnell Fig. 282, Carpenter & Patterson Fig. 108, or equal.
   2. Type B - Side Beam Bracket: Bracket shall be malleable iron and comply with MSS Type 34 and FEDSPEC Type 35. Grinnell Fig. 202, B-Line B3062, or equal.
   3. Type C - Malleable Beam Clamp With Extension Piece: Clamp and extension piece shall be malleable iron, tie rod shall be steel. Beam clamp shall comply with MSS and FEDSPEC Type 30. Grinnell Fig. 218 with Fig. 157 extension piece, B-Line B3054, or equal.

4. Type D - Steel Beam Clamp With Eye Nut: Beam clamp and eye nut shall be forged steel. Configuration and components shall comply with MSS and FEDSPEC Type 28. Grinnell Fig. 292, Carpenter & Patterson Fig. 297, or equal.
5. Type E - Framing Channel Post Base: Post bases shall be carbon steel, of standard design manufactured by framing channel manufacturer. Single channel: Unistrut P2072A, B-Line B280, or equal. Double channel: Unistrut P2073A, B-Line B281, or equal.
6. Type F - Welded Beam Attachment: Beam attachment shall be carbon steel and comply with MSS and FEDSPEC Type 22. B-Line B3083, Grinnell Fig. 66, or equal.
7. Type G - Welded Steel Bracket: Bracket shall be carbon steel and comply with MSS Type 32 and FEDSPEC Type 33 for medium welded bracket. Heavy welded bracket shall comply with MSS Type 33 and FEDSPEC Type 34.
8. Type H - Cast Iron Bracket: Bracket shall be cast iron, Carpenter & Patterson Fig. 340, or equal.
9. Type J - Adjustable Beam Attachment: Beam attachment shall be carbon steel, Carpenter & Patterson Fig. 151, B-Line B3082, or equal.
10. Type K - Double Channel Bracket: Wall channel shall be single channel framing channel as specified in paragraph 2.03 Framing Channel. Cantilever bracket shall be a carbon steel double framing channel assembly, Unistrut P2542 through P2546, B-Line B297-12 through B297-36, or equal.
11. Type L - Single Channel Bracket: Wall channel shall be single channel framing channel as specified in paragraph 2.03 Framing Channel. Cantilever bracket shall be a carbon steel single framing channel assembly, Unistrut P2231 through P2234, B-Line B198-6, B198-12, B196-18 and B196-24, or equal.
12. Type M - Wall Mounted Channel: Wall channel shall be single channel framing channel as specified in paragraph 2.03 Framing Channel.
13. Type N - Pipe Stanchion Floor Attachment: Baseplate shall be carbon steel with 1/2 inch minimum thickness. Anchor bolt holes shall be 1/16 inch larger than the anchor bolt diameter. The space between the baseplate and the floor shall be filled with nonshrink grout.
14. Type Q - ContinuoUs Concrete Inserts: shall be 1 5/8 by 1 3/8 Channel, cold formed 12 Ga. steel conforming to ASTM A 1001, stainless steel GR 33 or ASTM GR 33 A., hot dip galvanized conforming to ASTM A123 or A153, UNISTRUT P3200 Series, or approved equal.

E. Accessories:
1. Hanger Rods: Rods shall be carbon steel, threaded on both ends or continuous threaded and sized as specified.
2. Weldless Eye Nut: Eye nut shall be forged steel and shall comply with MSS and FEDSPEC Type 17. Eye nut shall be Grinnell Fig. 290, B-Line B3200, or equal.
3. Welded Eye Rod: Eye rod shall be carbon steel with eye welded closed. Inside diameter of eye shall accommodate a bolt diameter 1/8 inch larger than the rod diameter. Eye rod shall be Grinnell Fig. 278, B-Line B3211, or equal.
4. Turnbuckle: Turnbuckle shall be forged steel and shall comply with MSS and FEDSPEC Type 13. Turnbuckle shall be Grinnell Fig. 230, B-Line B3202, or equal.

5. Framing Channel: Framing channel shall be 1 5/8 inches square, roll formed, 12-gage carbon steel. Channel shall have a continuous slot along one side with in-turned clamping ridges. Single channel: Unistrut P1000, B-Line B22, or equal. Double channel: Unistrut P1001, B-Line B22A, or equal. Triple channel: Unistrut P1004A, B-Line B22X, or equal.

2.04 THERMAL PIPE HANGER SHIELD:

A. Thermal shields shall be provided at hanger, support and guide locations on pipe requiring insulation. The shield shall consist of an insulation layer encircling the entire circumference of the pipe and a steel jacket encircling the insulation layer. The thermal shield shall be the same thickness as the piping system insulation specified in Section 40 42 00. The standard shield shall be used for hot systems and the vapor barrier shield shall be used for cold systems. Stainless steel band clamps shall be used where specified to ensure against slippage between the pipe wall and the thermal shield.

B. Standard Shield:
   1. Insulation:
      a. Hydrous calcium silicate, high density, waterproof
      b. Compressive strength: 100 psi average
      c. Flexural strength: 75 psi average
      d. K factor: 0.38 at 100 degrees F mean
      e. Temperature range: 20 degrees F to 500 degrees F
   2. Steel Jacket: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.
   3. Connection: Shield shall have butt connection to pipe insulation. Steel jacket and insulation shall be flush with end.

C. Vapor Barrier Shield:
   1. Insulation:
      a. Hydrous calcium silicate, high density, waterproof
      b. Compressive strength: 100 psi average
      c. Flexural strength: 75 psi average
      d. K factor: 0.38 at 100 degrees F mean
      e. Temperature range: 20 degrees F to 500 degrees F
   2. Steel Jacket: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.
   3. Connection: Shield shall have butt connection to pipe insulation. Insulation shall extend 1 inch each side of steel jacket for vapor tight connection to pipe insulation vapor barrier.

PART 3 EXECUTION

3.01 HANGER AND SUPPORT LOCATIONS

A. Locate hangers and supports as near as possible to concentrated loads such as valves, flanges, etc. Locate hangers, supports and accessories within the maximum span lengths specified in the project manual to support continuous pipeline runs unaffected by concentrated loads.

B. Locate at least one hanger or support within 2 feet from a pipe change in direction.

C. Locate hangers and supports to ensure that connections to equipment, tanks, etc., are substantially free from loads transmitted by the piping.

D. Where piping is connected to equipment, a valve, piping assembly, etc., that will require removal for maintenance, support the piping in such a manner that temporary supports shall not be necessary for this procedure.

E. Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

3.02 INSTALLATION

A. Weld and bolt attachments to the building structural steel shall be in accordance with the requirements of the AISC Manual of Steel Construction. Unless otherwise specified, there shall be no drilling or burning of holes in the building structural steel.

B. Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.

C. Install items to be embedded before concrete is poured. Fasten embedded items securely to prevent movement when concrete is poured.

D. Embedded anchor bolts shall be used instead of concrete inserts for support installations in areas below water surface or normally subject to submerging.

E. Install thermal pipe hanger shields on insulated piping at required locations during hanger and support installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

F. Hanger and support components in contact with plastic pipe shall be free of burrs and sharp edges.

G. Rollers shall roll freely without binding.

H. Finished floor beneath Type N structural attachments and framing channel post bases shall be roughed prior to grouting. Grout between base plate and floor shall be free of voids and foreign material.

I. Baseplates shall be cut and drilled to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.

J. Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.03 ADJUSTMENTS

A. Adjust hangers and supports to obtain required pipe slope and elevation. Shims made of material that is compatible with the piping material may be used. Stanchions shall be adjusted prior to grouting their baseplates.

3.04 ANCHOR BOLTS

A. Anchor bolts in new concrete shall be cast in place. Refer to Section 05 05 20.

3.05 INSPECTION AND CERTIFICATION

A. The Design Professional retained by the Contractor under the provisions of spect the pipe hangers, support and restraint systems at not less than bi-weekly intervals during construction and furnish the Construction Manager with monthly reports. The Design Professional shall inspect the completed pipe hanger, support and restraint system before the Owner assumes beneficial occupancy and provide written certification, without any qualification statements, that the installation conforms to the design professional’s design and the Contract Document requirements as may be described in other Sections or on the drawings. All reports shall bear the Design Professional's seal and signature in accordance with the laws, rules and regulations of the state.

APPENDIX A: PIPE HANGERS AND SUPPORTS TABLES

TABLE A - SUPPORT SPACING AND ALLOWABLE ROD LOADS

NOMINAL PIPE SIZE (INCHES)	SUPPORT ROD SIZE AND MAXIMUM LOAD PER ROD - SEE NOTES 1 AND 2		MAXIMUM SUPPORT SPACING (FEET)				
	ROD SIZE (INCHES)	MAX LOAD (POUNDS)	STEEL	COPPER	PLASTIC SEE NOTE 4	CAST IRON SEE NOTE 5
3/8 TO 3/4	3/8	610	5	5	CONTINUOUS	---
1	3/8	610	5	5	5	---
1-1/4	3/8	610	5	5	5	---
1-1/2	3/8	610	5	5	5	---
2	3/8	610	10	5	5	
2-1/2	3/8	610	10	10	5	
3	3/8	610	10	20	5	
4	1/2	1130	10	20	5	
6	5/8	1810	15	20	5	
8	3/4	2710	15	20	5	
10	3/4	2710	20	---	5	
12	1	4960	20	---	10	
14	1	4960	20	---	---	
16	1	4960	20	---	---	
18	1	4960	20	---	---	
20	1-1/4	8000	20	---	---	
24	1-1/4	8000	20	---	---	
30	1-1/2	11630	20	---	---	

12 FEET FOR PRESSURE PIPE
10 FEET FOR SOIL PIPE

TABLE A NOTES:

1. DESIGN WEIGHT SHALL BE TWICE THE WEIGHT OF THE PIPE FULL OF WATER PLUS THE WEIGHTS OF VALVES, FITTINGS, INSULATING MATERIALS AND SUSPENDED HANGER COMPONENTS ON THE RUN OF PIPE BEING SUPPORTED.
2. ROD SIZES SHOWN ARE FOR THE SUPPORT OF A SINGLE PIPE. WHEN SUPPORTING MORE THAN ONE PIPE, ROD SHALL BE SIZED USING DESIGN WEIGHTS (SEE NOTE 1) TO DETERMINE THE TOTAL DESIGN LOAD. THE TOTAL DESIGN LOAD SHALL NOT EXCEED THE MAXIMUM LOADS IN THE TABLE ABOVE.
3. PIPE SHALL NOT HAVE POCKETS FORMED IN THE SPAN DUE TO SAGGING OF THE PIPE BETWEEN SUPPORTS CAUSED BY THE WEIGHT OF THE PIPE, MEDIUM IN THE PIPE, INSULATION, VALVES AND FITTINGS.
4. SPAN SHOWN IS FOR SCHEDULE 80 PVC PIPE AT 100°F. SPANS FOR OTHER PLASTICS, OTHER PVC PIPE SCHEDULES AND PIPES AT HIGHER TEMPERATURES SHALL BE SHORT- ENED IN ACCORDANCE WITH THE PIPE MANUFACTURER'S RECOMMENDATIONS. "CONTINUOUS" MEANS PIPE SHALL BE IN UNISTRUT OR SIMILAR CHANNEL.
5. PROVIDE A MINIMUM OF ONE HANGER PER PIPE LENGTH, WITHIN 4-INCHES OF THE BELL.
6. PIPE HANGER AND SUPPORT SELECTION SHALL BE IN ACCORDANCE WITH TABLE B (M2302) AND SPECIFICATION SECTION 15096.

TABLE B HANGER AND SUPPORT SELECTIONS

SYSTEM TEMP RANGE DEG F	INSULATION NOTE 1	PIPE ATTACHMENTS								BUILDING STRUCTURAL ATTACHMENTS			
		HORIZONTAL							VERTICAL	STEEL AND/OR MALL. IRON			
		STEEL STRAPS	STEEL BANDS	STEEL CLAMPS	CAST IRON HANGING ROLLS	CAST IRON SUPPORTING ROLLS	STEEL TRAPEZES AND RACKS	THERMAL HANGER SHIELDS	STEEL OR CAST IRON STANCHIONS	STEEL RISER CLAMPS	INSERTS	BEAM CLAMPS	WELDED AND BOLTED ATTACHMENTS	BRACKETS
HOT A-1 120 TO 450	COVERED	13	1, 2	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	6, 7 13	1, 2	3	4, 5	8	20, 21	NONE	10					
HOT A-2 451 TO 750	COVERED	13	1	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	NONE	NONE	3	NONE	NONE	20, 21	NONE	NONE					
HOT A-3 OVER 750	COVERED	13	1	3 (ALLOY)	4, 5	8	20, 21	SEE SPEC	10	11, 12	NONE	C, D	F, J, M	B, G, H, K, L
	BARE	13	NONE	3 (ALLOY)	NONE	NONE	20, 21	NONE	NONE					
AMBIENT B 60 TO 119	COVERED	13	1, 2	3	4, 5	8	20, 21	SEE SPEC	9,10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	6, 7 13	1, 2	3	4, 5	8	20, 21	NONE	9,10					
COLD C-1 33 TO 59	COVERED	13	1, 2, 3	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	6, 7 13	1, 2, 3	3	4, 5	8	20, 21	NONE	10					
COLD C-2 -2 TO 32	COVERED	13	1, 2, 3	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	NONE	1, 2, 3	3	4, 5	8	20, 21	NONE	10					

TABLE B NOTES:

1. HANGERS ON INSULATED SYSTEMS SHALL INCORPORATE THERMAL HANGER SHIELDS.
2. HANGER AND SUPPORT SPACING SHALL BE IN ACCORDANCE WITH TABLE A (M2301).

TABLE C
SEISMIC RESTRAINT SPACING

NOM. PIPE SIZE	MAXIMUM SPAN BETWEEN BRACES		BRACE TYPE	MAXIMUM BRACE LENGTH
	LATERAL BRACE (FEET)	LONGITUDINAL BRACE (FEET)		
2	40	80	A1	9'-4"
2-1/2	40	80	A1	9'-4"
3	40	80	A1	9'-4"
4	40	80	A1	9'-4"
6	40	80	A1	9'-4"
8	40	40	A1	9'-4"
10	40	40	A1	9'-4"
12	40	40	A2	10'-0"
14	30	30	A2	10'-0"
16	25	25	A2	10'-0"
18	20	20	A2	10'-0"
20	16	16	A2	10'-0"
24	10	10	A2	10'-0"

(S) - STANDARD WALL

END OF SECTION

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SECTION 40 05 07.13

SEISMIC RESTRAINTS FOR PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies seismic restraints for bracing all piping systems specified in Section 40 05 01. This section does not include seismic restraints for fire sprinkler systems.

B. Provide professional engineering services for a piping system dsign engineer (hereinafter the "Design Professional") as specified in Section 40 05 01, this Section, and related sections.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 61 45 – Area Exposure Designations
   3. Section 01 66 00 – Product Storage and Handling Requirements
   4. Section 01 73 24 – Design Requirements for Non-Structural Components and Non-Building Structures
   5. Section 03 30 00 – Cast-in-Place Concrete
   6. Section 05 05 20 – Anchor Bolts
   7. Section 40 05 01 – Piping Systems
   8. Section 40 05 02 – Piping System Schedules
   9. Section 40 05 06 – Specialty Couplings and Adapters for Process Piping
   10. Section 40 05 07 – Hangers and Supports for Process Piping
   11. Section 40 05 07.16 – Expansion Control for Piping
   12. Section 40 05 45 – Piping System Identification
   13. Section 40 42 00 – Insulation for Exposed Piping and Equipment

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction Manual of Steel Construction, Allowable Stress Design, 9th Edition
MFMA-2	Metal Framing Standards Publication
MFMA-101	Guidelines for the Use of Metal Framing
MSS SP-58	Pipe Hangers and Supports - Materials, Design and Manufacture

Reference	Title
MSS SP-69	Pipe Hangers and Supports - Selection and Application
MSS-SP-89	Pipe Hangers and Supports – Fabrication and Installation Practices
SMACNA	Seismic Restraint Manual—Guidelines for Mechanical Systems

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. Longitudinal direction: direction parallel to the pipe axis.
   2. Lateral direction: direction perpendicular to the pipe axis.

1.05 ADMISTRATIVE REQUIREMENTS

A. Cordination:
   1. Coordination required with the design of piping systems, expansion joints, pipe supports, and expansion control and seismic restraints.
   2. Refer to Section 40 05 01 for additional coordination requirements.
   3. Refer to paragraph 1.09 Seismic Restraint Design for additional coordation requirements.

1.06 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Seismic restraint system drawings and calculations as specified in paragraph 1.09 Seismic Restraint Design.
   3. Seismic restraint locations and legend as specified in paragraph 3.01.

B. Informational Submittals:
   1. Procedures: Section 01 33 00
   2. The Design Professional's reports and certification of final installation as specified in Section 40 05 01 and paragraph 3.03.

1.07 QUALITY ASSURANCE

A. Refer to Section 40 05 01 for additional quality assurance requirements.

B. Refer to paragraph 1.09 Seismic Restraint Design for additional quality assurance requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Additional requirements: 40 05 01

1.09 SEISMIC RESTRAINT DESIGN

A. Design Professional:
   1. The seismic restraint system shall be designed by the Design Professional retained under Section 40 05 01. Seismic restraint details shall be designed in conjunction with preparation of pipe system hangers and drawings specified in Section 40 05 01.
   2. All drawings and work product for the seismic restraint system shall bear the design professional's registration seal and signature. The requirement, however, shall not be construed as relieving the Contractor of responsibility for this portion of the work.

B. Restraint Selection:
   1. The Contractor shall select, locate and provide seismic restraints for piping in accordance with this section. As set forth in Section 40 05 01, this work shall be the product of a Design Professional retained by the Contractor.
   2. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the restraint to be used at each point.
   3. Seismic restraints may be omitted from the following installations:
      a. Gas piping less than 1-inch inside diameter.
      b. All other piping less than 2 1/2-inch inside diameter.
   4. Piping systems shall not be braced to dissimilar parts of a building or to dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
   5. Restraints shall be sized to fit the outside diameter of the pipe, tubing, or, where specified, the outside diameter of insulation.
   6. There shall be no contact between a pipe and restraint component of dissimilar metals. The contractor shall prevent contact between dissimilar metals when restraining copper tubing by the use of copper-plated, rubber, plastic or vinyl coated, or stainless steel restraint components.
   7. Branch lines shall not be used to brace main lines.
   8. Seismic bracing shall not limit the expansion and contraction of the piping system.

PART 2 PRODUCTS

2.01 PERFORMANCE/ DESIGN REQUIREMENTS

A. Service Conditions:
   1. Provide seismic bracing to resist seismic loading caused by forces applied at the individual pipe's center of gravity. Designed seismic bracing for seismic loading as specified in Section 01 73 24. Seismic loading shall be assumed to be acting in the lateral, longitudinal, and vertical directions simultaneously.
   2. Provide all piping systems with seismic restraints conforming to governing state and local codes.
   3. Seismic restraints shall conform to the guidelines given in the SMACNA Seismic Restraint Manual for the Seismic Hazard Level consistent with the requirements of governing state and local codes. In case of conflict, the governing state or local code shall be followed.

2.02 MANUFACTURERS

A. Standard pipe restraints and components shall be manufactured by Carpenter & Patterson, B-Line, Kin-Line, ITT Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or approved equal.

B. Pipe restraint materials, design, manufacture, installation, and application shall conform to the requirements of MSS SP-58, MSS-SP-69, MSS-SP-89, MFMA-1, and MFMA-101.

2.03 MATERIALS

A. General:
   1. Unless otherwise specified, restraints manufactured of iron or steel, including braces, pipe and structural attachments, shall be hot-dip galvanized after fabrication.
   2. Nuts, bolts and washers, fittings and accessories, may be mechanically zinc-coated except for those subject to moisture or corrosive atmosphere, which are listed in Section 26 05 00-1.05 Corrosive Areas; those compounds shall be type 304 stainless steel.
   3. Also listed in Section 26 05 00-1.05 Corrosive Areas are corrosive areas specifically requiring fiberglass materials. In those areas, all pipe supports, anchor and seismic brace components (not just fittings and accessories) shall be made of fiberglass.

2.04 CONFIGURATION, COMPONENTS, AND FEATURES

A. Thermal Pipe Hanger Shield:
   1. Thermal shields shall be provided at seismic restraint locations on pipe requiring insulation. Thermal pipe hanger shields shall be as specified in Section 40 05 07-2.04. Stainless steel band clamps shall be provided on thermal shields at longitudinal pipe restraint locations.

PART 3 EXECUTION

3.01 PIPE RESTRAINT LOCATIONS

A. Locate the first seismic restraint on a piping system not more than 10 feet from the main riser, entrance to a building or piece of equipment.

B. Brace ductile and cast iron pipe on each side of a change in direction of 90 degrees or more. Brace or stabilize joints in risers between floors.

C. At a minimum, brace no-hub and bell and spigot cast iron soil pipe longitudinally every 20 feet and laterally every 10 feet.

D. Lateral bracing for one pipe section may also act as longitudinal bracing for the pipe section connected perpendicular to it, if the bracing is installed within 24 inches of the elbow or tee of the same size.

E. Indicate seismic restraint locations and components on the piping layout drawings required by Section 40 05 01. The drawings shall bear a legend giving load information and restraint component selection at each restraint location and shall be sealed and signed by the Design Professional retained by the Contractor for design of the pipe hanger and support system under the provisions of Section 40 05 01.

3.02 INSTALLATION

A. Use rod stiffener assemblies at seismic restraints for hanger rods over 6 inches in length. Use a minimum of two rod stiffener clamps on any rod stiffener assembly.

B. Install lateral and longitudinal bracing between 45 degrees above and 45 degrees below horizontal, inclusive, relative to the horizontal centerline of the pipe.

C. Weld and bolt attachments to the building structural steel in accordance with the requirements of AISC M011. There shall be no drilling or burning of holes in the building structural steel without approval of the Engineer.

D. Use embedded anchor bolts instead of concrete inserts for seismic brace installations in new concrete areas below water surface or normally subject to submerging. Otherwise, design and provide anchor bolts in accordance with Section 05 05 20.

E. Install thermal pipe hanger shields on insulated piping at required locations during restraint installation. Make butt joint connections to pipe insulation at the time of insulation installation in accordance with the manufacturer's recommendations.

F. Restraint components in contact with plastic pipe shall be free of burrs and sharp edges.

G. Rollers shall roll freely without binding.

H. Provide plastic or rubber end caps at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.03 INSPECTION AND CERTIFICATION

A. The Design Professional retained by the Contractor under the provisions of Section 40 05 01 shall inspect the seismic restraint system at not less than bi-weekly intervals during construction and furnish the Engineer with monthly reports.

B. The Design Professional shall inspect the completed seismic control system before the Owner assumes beneficial occupancy and provide written certification in accordance with Section 40 05 07 requirements.

END OF SECTION

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SECTION 40 05 07.16

EXPANSION CONTROL FOR PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies expansion control for the piping systems specified in paragraph 2.01 Service Requirements. This section addresses pipe anchorage, pipe guides, and expansion control by either expansion joints or pipe deflection.

B. Provide professional engineering services for a piping system dsign engineer (hereinafter the "Design Professional") as specified in Section 40 05 01, this Section, and related sections.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 61 45 – Area Exposure Designations
   3. Section 01 66 00 – Product Storage and Handling Requirements
   4. Section 01 73 24 – Design Requirements for Non-Structural Components and Non-Building Structures
   5. Section 03 30 00 – Cast-in-Place Concrete
   6. Section 05 05 20 – Anchor Bolts
   7. Section 09 90 00 – Coating Systems
   8. Section 40 05 01 – Piping Systems
   9. Section 40 05 02 – Piping System Schedules
   10. Section 40 05 06 – Specialty Couplings and Adapters for Process Piping
   11. Section 40 05 07 – Hangers and Supports for Process Piping
   12. Section 40 05 07.13 – Seismic Restraints for Piping
   13. Section 40 05 45 – Piping System Identification
   14. Section 40 42 00 – Insulation for Exposed Piping and Equipment

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design - 9th Edition
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes

Reference	Title
EJMA STDS	Standards of Expansion Joint Manufacturers' Association, Edition No. 5

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:

Term	Definition
Expansion joint	Any device containing one or more bellows used to absorb dimensional changes.
Main anchor	An attachment between a structure and a pipe which must withstand the full pipeline thrust due to pressure, pipe bending, pipe compression, flow, spring forces, pipe and contents weight and other pipe forces.
Intermediate anchor	An attachment between a structure and a pipe which withstands the same forces as a main anchor except the pressure forces.
Sliding anchor	An attachment between a structure and a pipe which absorbs forces in one direction while permitting motion in another.
Pipe guide	A device fastened to a structure, which permits the pipeline to move freely in only one direction, along the axis of the pipe.
Pipe section	That portion of pipe between two anchors.
Planar pipe guide	A device fastened to a structure, which permits transverse movement or bending of the pipeline in one plane.
Lateral direction	Direction perpendicular to the pipe axis
Longitudinal direction	Direction parallel to the pipe axis

1.05 ADMISTRATIVE REQUIREMENTS

A. Cordination:
   1. Coordination required with the design of piping systems, expansion joints, pipe supports, and expansion control and seismic restraints.
   2. Refer to Section 40 05 01 for additional coordination requirements.
   3. Refer to paragraph 1.09 Expansion Control Design for additional coordation requirements.

1.06 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations.
   3. Identify expansion control locations and components indicated on piping layout drawings as specified in Section 40 05 01.
   4. Expansion control schedules as specified in paragraph 4.01.

B. Information Submittals:
   1. Procedures: Section 01 33 00.
   2. Anchor bolt calculations in accordance with Section 05 05 20 requirements.

3. The Design Professional's reports and final certification, as specified under paragraph 3.02

1.07 QUALITY ASSURANCE

A. Refer to Section 40 05 01 for additional quality assurance requirements.

B. Refer to paragraph 1.09 Expansion Control Design for additional quality assurance requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Additional requirements: 40 05 01.

1.09 EXPANSION CONTROL DESIGN

A. Design:
   1. The expansion control system shall be designed by the Contractor's Design Professional selected under Section 40 05 01.
   2. Expansion control details shall be designed in conjunction with preparation of pipe system hangers and seismic restraint systems drawings specified in Section 40 05 01.
   3. The resulting drawings, calculations, and work product for the expansion control system shall bear the Design Professional's registration seal and signature. The requirement, however, shall not be construed as relieving the Contractor of responsibility for this portion of the work.

B. Design Guidelines:
   1. The Design Professional shall use the following guidelines in preparation of the designs and calculations specified in paragraph 1.09 Expansion Control Design.
      a. The difference between the minimum and maximum temperatures listed in the table in paragraph 2.01 Service Requirements shall be used for calculating pipe expansion.
      b. Published coefficients of thermal expansion for pipe materials shall be used for the listed temperature range. The source of the coefficients of expansion used in the calculations shall be included with the information provided as Product Data.
      c. Expansion control systems shall be designed for maximum reliability. Unless otherwise indicated on the Drawings, "L", "U", or "Z" bends shall be employed to control expansion in preference over expansion joints.
      d. Expansion control systems using pipe bends shall be designed to limit bending stress in the pipe associated with deflection at the worst case temperature difference. The maximum allowable bending stress shall be 1/3 of the yield stress for the pipe material. If loading conditions or uncertainties warrant, a lower allowable stress value shall be used. A recognized pipe bending stress calculation method and documentation supporting its use shall be provided as Product Data.

e. The requirements set forth in Section 40 05 06.23 shall prevail if expansion joints are used. Expansion control design for expansion joints shall conform to the guidelines given in the Standards of The Expansion Joint Manufacturers Association, Inc. (EJMA).

f. If the Design Professional chooses to use expansion control or pipe support methods that involve higher loadings on the structure than are specified and/or shown on the drawings, the Construction Manager shall be notified in the submittal required in Section 40 05 01. The requested loads shall be listed and the Construction Manager will redesign the structure as necessary at the Contractor's expense.

g. The test pressures listed in the Piping Systems Schedules sheets shall be used when calculating pressure forces.

h. Pipe guides or planar pipe guides shall be provided to control the movement of pipes when "L", "U", or "Z" bends are used for expansion control. The guides shall be located as indicated in EJMA standards. An alternative recognized standard may be used for this purpose only upon approval by the Construction Manager.

i. For piping systems with potentially large loads, recommended main anchor locations are shown on the drawings. Intermediate anchors shall be provided as needed. Maximum forces that the structure can withstand at the main anchor points are noted on the drawings. Anchors shall be designed to attach to the structure and solidly to the pipe. Pipe clamps or U-bolts are not allowed unless they are designed to withstand the forces imposed upon the anchor and have stops welded to the pipe so that the pipe cannot slip in the anchor.

j. Anchors and guides shall be coordinated with the pipe support systems specified in Section 40 05 07 and seismic restraints specified in Section 40 05 07.13.

k. The design of the expansion control, pipe support and seismic restraints for the listed piping systems shall be integrated to provide maximum flexibility for maintenance access to equipment, appurtenances such as valves etc., and to the pipe itself.

l. The piping layout indicated shall be reviewed in relation to, surrounding structures, adjacent piping and equipment before selecting the anchors, guides, and expansion control method to be used at each point.

m. There shall be no metal-to-metal contact between a pipe and restraint component of dissimilar metals.

n. Branch lines shall not be used to anchor main lines.

o. For elevated pipe sections, fabricated support frames or other appropriate structures shall be designed to withstand the specified loads plus gravity and seismic loads. The supports shall be designed to provide access to equipment, walkways, gates, and other piping.

PART 2 PRODUCTS

2.01 PERFORMANCE/ DESIGN REQUIREMENTS

A. Service Conditions:

1. Expansion control as specified in this section shall be provided to control pipe movements and loads occurring as a result of pipeline temperature changes.
2. Those piping systems listed in Section 40 05 02 shall be provided with expansion control conforming to good engineering practice as required.

2.02 MATERIALS

A. Unless otherwise specified, anchors, and guides shall be manufactured of iron or steel, including braces, pipe and structural attachments, and shall be hot-dip galvanized after fabrication. Supports cast integrally with cast iron fittings are specifically prohibited for use in any application where shear forces may be imposed on the support.

B. Structural anchors may be fabricated from structural steel and coated as specified in Section 09 90 00.

C. Nuts, bolts and washers may be zinc-plated except for those subject to moisture or corrosive atmosphere, as specified in Sections 26 05 00-1.04 , which shall be Type 304 stainless steel.

D. Also listed in Section 26 05 00-1.04 are corrosive areas specifically requiring fiberglass materials. In those areas, all pipe support, anchor and brace components (not just fittings and accessories) shall be made of fiberglass.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the expansion control system in accordance with the drawings required in paragraph 1.09 Expansion Control Design.

B. Metal-to-metal contact between a pipe and pipe anchor of dissimilar metals is not permitted.

C. Weld and bolt attachments to the building structural steel in accordance with the requirements of the AISC Manual of Steel Construction. There shall be no drilling or burning of holes in the building structural steel without approval of the Construction Manager.

D. Provide embedded anchor bolts instead of concrete inserts, wedge anchors, expansion anchors, adhesive, or other non-embedded type of anchor for expansion control installations in areas below water surface or normally subject to submergence. Anchor bolt installation as specified in Section 05 50 20.

E. Install thermal pipe hanger shields on insulated piping at required locations during guide installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

F. Components in contact with plastic pipe shall be free of burrs and sharp edges.

G. Roller assemblies are specified in the Drawings. Roller shall roll freely without binding.

H. Provide plastic or rubber end caps at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.02 INSPECTION AND CERTIFICATION

A. The Design Professional retained by the Contractor under the provisions of Section 40 05 01 and this Section shall inspect the completed expansion control system at not less than bi-weekly intervals during construction and furnish the Construction Manager with monthly reports.

B. The Design Professional shall inspect the completed expansion control system before the Owner assumes beneficial occupancy and provide written certification in accordance with Section 40 05 07 requirements.

PART 4 SCHEDULES

4.01 EXPANSION CONTROL SCHEDULES

A. General: Anchor, guide, and expansion joint locations shall be indicated on the piping layout drawings required by Section 40 05 01 and paragraph 1.09 Expansion Control Design. In addition, schedules shall be prepared as specified below.

B. Anchors:
   1. The anchor schedule shall list as a minimum:
      a. Anchor Point Label
      b. Pipe Size and Service
      c. Contract Drawing No.
      d. Layout Drawing No.
      e. Forces
      f. Load, pounds
      g. Direction
      h. Anchor Description
      i. Remarks

C. Guides:
   1. The guide schedule shall list as a minimum:
      a. Guide Label
      b. Pipe Size and Service
      c. Contract Drawing No.
      d. Layout Drawing No.
      e. Guide Description
      f. Remarks

D. Expansion Joints:
   1. The expansion joint schedule shall list as a minimum:
      a. Expansion Joint Label
      b. Pipe Size and Service
      c. Contract Drawing No.
      d. Layout Drawing No.

e. Movement, inches
    1) Lateral movement
    2) Compression movement
    3) Extension movement
    4) Angular movement
f. Maximum Spring Force, pounds
g. Test Pressure, PSIG
h. Pressure Force, pounds
i. Total Forces
j. Load, pounds
k. Direction
l. Expansion Joint Description
m. Special Features
n. Remarks

END OF SECTION

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SECTION 40 05 19

DUCTILE IRON PIPE

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies ductile iron pipe and fittings.

1.02 RELATED SECTIONS

A. Section 01 33 00 – Submittal Procedures

B. Section 01 66 00 – Product Storage and Handling Requirements

C. Section 40 05 01 – Piping Systems

D. Section 40 05 02 – Piping System Schedules

E. Section 40 05 06.16 – Mechanical Pipe Couplings

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, and 250
ASME B16.5	Pipe Flanges and Flanged Fittings
ASTM C150	Portland Cement
ASTM A716	Standard Specification for Ductile Iron Culvert Pipe
AWWA C104	Cement-Mortar Lining for Ductile- Iron and Gray-Iron Pipe
AWWA C105	Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110	Ductile-Iron and Gray-Iron Fittings
AWWA C111	Rubber-Gasket Joints for Ductile- Iron and Gray-Iron Pressure Pipe and Fittings
AWWA C115	Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges
AWWA C116	Protective Fusion-Bonded-Epoxy Coating for the Interior and Exterior Surfaces for Ductile-Iron and Gray-Iron Fittings.
AWWA C150	Thickness Design of Ductile-Iron Pipe
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast
AWWA C153	Ductile-Iron Compact Fittings
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances.
AWWA C606	Grooved and Shouldered Type Joints
ISO 8179-1	Ductile Iron Pipes – Externa Zinc-based Coating - Part 1: Metallic Zinc with Finishing Layer

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00
   2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager is the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Manufacturer's product data, catalog cuts, dimensions and materials. Indicate each Piping System Schedule where the product will be used.

B. Informational Submittals:
   1. Procedures: Section 01 33 00
   2. Certifications indicated in the following documents:
      a. ASTM A716, sworn statement of inspection and certification.
      b. AWWA C110, certification of inspection and testing.
      c. AWWA C111, record of specified tests.
      d. AWWA C115, affidavit of compliance.
      e. AWWA C151, manufacturer's statement and affidavit of compliance.
      f. AWWA C606, affidavit of compliance.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00 for shipment and storage.

PART 2 PRODUCTS

2.01 MATERIALS

A. All pipe system materials to be new, free from defects and conforming to the requirements and standards identified in Section 40 05 02 and related sections.

B. Pipe.
   1. Provide increased wall thickness where specified on the Drawings.

2.02 PIPE LINING

A. Provide pipe and fittings with lining as specified in Piping System Schedules in Section 40 05 02.00 through 40 05 02.99. Requirements for each lining type are specified in this Section.

1. Cement Mortar Lining.
    a. Factory applied.
    b. Line pipe and fittings with cement mortar as specified in AWWA C104.
    c. Cement shall be ASTM C150, Type II or V, low alkali, containing less than 0.60 percent alkalis
    d. Patch field welds, cuts, connections, and damaged lining in accordance with AWWA C104.
2. Glass Lining.
    a. Factory or Shop applied.
    b. Line pipe and fittings with glass lining, 10 mils minimum thickness, using a dual layer coating system of vitreous material.
    c. Provide continuous coverage glass lining as tested by a low voltage holiday detector with only isolated voids permitted due to casting anomalies. Voids, other than isolated pinholes, shall be cause for rejection.
    d. Pipe bored, machined, or grit blasted to remove any voids, protrusions or surface irregularities and to obtain a smooth continuous surface for glass lining. Fittings shall be ground or grit blasted to remove any voids, protrusions or surface irregularities.
    e. Damaged glass lining cannot be repaired. Damaged glass lined pipe must be replaced.
    f. Candidate manufacturers:
        1) Ferrock, MEH 32.
        2) Vitco SG 14.
        3) CBGL911.
        4) Approved equal.
3. Ceramic Epoxy
    a. Factory applied.
    b. Line pipe and fittings with amine cured novolac epoxy containing at least 20 percent ceramic quartz pigment.
    c. 40 mils minimum thickness.
    d. Candidate Manufacturers:
        1) Protecto 401
        2) Approved Equal
4. Unlined
    a. Provide pipe and fittings with a bare metal (no coating) interior.

2.03 PIPE COATING

A. Provide pipe with coating as specified in Piping System Specification Sheets in Section 40 05 02. Requirements for each coating type are specified in this Section.
   1. Asphaltic Coating
      a. Factory applied.
      b. Coat pipe and fittings with 1 mil, minimum, of asphaltic material as specified in AWWA C151.
   2. Zinc Coating with Asphaltic Top Coat
      a. Factory applied.
      b. Coat pipe and fittings with a layer of arc-sprayed zinc per ISO 8179-1. Zinc applied at not less than 200 g/m^2 of pipe surface area. Apply a finishing layer asphaltic topcoat per AWWA C151.
   3. Polyethylene Encasement.
      a. Field installed.
      b. Encase pipe and fittings in polyethylene wrap as specified in AWWA C105.
      c. Polyethylene tubing shall be Anti-microbial, Low Density Polyethylene (LDPE) or High Density Polyethylene (HDPE):
         1) LDPE: 8-mil linear low density polyethylene film meeting the requirements of AWWA C105, impregnated with ½ percent NM-100 anti-microbial compound. Fulton Enterprises Biofilm, or Approved Equal.
         2) HDPE: 4-mil high-density, cross-laminated polyethylene film meeting the requirements of AWWA C105.
      d. Seam/Joint Tape – Acceptable manufacturer:
         1) Polyken No. 900 (polyethylene).
         2) Scotchwrap No. 50 (polyvinyl).
         3) Approved Equal.
   4. V-Bio Enhanced Polyethylene Encasement
      a. Field installed
      b. Encase pipe and fittings in polyethylene tubing as specified in AWWA C105.
      c. Three layer, co-extruded, linear low density polyethylene wrap.
      d. 8 mils minimum wrap thickness
      e. Inner surface of polyethylene wrap infused with anti-microbial biocide and corrosion inhibitor.
      f. Candidate Manufacturers:
         1) V-Bio
         2) Approved Equal
   5. Epoxy Primer.
      a. Factory or shop applied.
      b. Coat pipe and fittings with Amide or Polyamide cured epoxy, 4 to 6 mils DFT
   6. Uncoated
      a. Provide pipe and fittings with a bare metal (no coating) exterior.

2.04 FUSION-BONDED EPOXY LINING AND COATING FOR FITTINGS

A. Factory or shop applied.

B. Fusion Bonded Epoxy lining and coating per AWWA C116.

2.05 JOINTS, AND COUPLINGS

A. Push-On (PO) Joint (Unrestrained)
   1. Rubber ring compression gasket, push-on type joints conforming to AWWA C111.
   2. 2.5 degrees or half the manufacturers allowable deflection at rated operating pressure for joints on 4-inch through 30-inch pipe.
   3. Candidate manufacturers:
      a. American Cast Iron Pipe Company Fastite
      b. U.S. Pipe Tyton Joint
      c. Approved Equal

B. Restrained Push-On (RPO) Joint
   1. Restrained, rubber ring compression gasket, push-on joints conforming to AWWA C111
   2. Restrained by the interference of metallic rings, bolts, locking segments or other interlocking components with flanges, lugs, beads, grooves or retainer rings that are integrally cast into or welded onto both ends of the joint. Restrained joints with gripping wedges, or gripping gaskets, radial pads, or other devices that penetrate, grip, or embed in the pipe material to resist axial thrust loads are not acceptable.
   3. Candidate manufacturers:
      a. American Cast Iron Pipe Company, Flex-Ring or Lok-Ring
      b. U.S. Pipe, TR Flex or HP LOK
      c. Approved Equal

C. Mechanical Joint (MJ)
   1. Mechanical Joints per AWWA C110 and AWWA C111.

D. Restrained Mechanical Joint (RMJ)
   1. Restrained by tie-rods/bolts tying the gasket gland to a second retainer/follower gland behind a welded ring on the spigot end of the joint. Restrained joints with gripping wedges, or gripping gaskets, radial pads, or other devices that penetrate, grip, or embed in the pipe material to resist axial thrust loads are not acceptable.
   2. Fully restrained mechanical joints for above or below ground service conforming to AWWA C110 and AWWA C111.
   3. Candidate manufacturers:
      a. American Cast Iron Pipe Company, Mechanical Joint Coupled Joint
      b. U.S. Pipe, MJ HARNESS-LOK
      c. Approved Equal

E. Grooved couplings (CGRV) and fittings.
   1. When pipe wall thickness does not meet the minimum requirements of AWWA C606 for rolled or cut groove joints, provide shouldered ends per the requirements of AWWA C606.
   2. Candidate manufacturers.
      1) Victaulic
      2) Gruvlok
      3) Approved equal.
   3. Grooved end flanged coupling adapters candidate manufacturers:
      a. Victaulic Style 341
      b. Approved Equal
   4. Grooved end transition couplings to steel pipe candidate manufacturers:
      a. Victaulic Style 307
      b. Approved Equal

F. Bell and Ball Spigot Flexible (BABS) Joint.
   1. Boltless type with retainer lock to prevent rotation after assembly
   2. Up to 15 degrees of deflection at operating pressure
   3. Candidate manufacturers.
      a. Flex-Lok Joint by American Cast Iron Pipe
      b. USIFlex by US Pipe
      c. Approved equal.

G. Sleeve/Transition Coupling.
   1. When connecting new ductile iron piping to existing piping, field verify outside diameters of existing pipe prior to connection. See drawings for location and installation requirements.
   2. Candidate Manufacturers.
      a. Romac, "501"
      b. JCM, "212"
      c. Smith-Blair, "461"
      d. Approved Equal

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Follow piping routes specified on the drawings as closely as possible. Submit proposed deviations in accordance with Section 01 33 00.
   2. Install pipe in accordance with AWWA C600.
   3. Make connections to existing structures and manholes so that the finished work will conform as nearly as practicable to the requirements specified for new manholes, including necessary concrete work, cutting and shaping. Shape concrete mortar within any structure and manhole as specified.

B. Insulating Sections: Where a metallic nonferrous pipe/appurtenance connects to ferrous pipe/appurtenance, provide an insulating section per Section 40 05 06.16.

C. Anchorage: Provide as specified on the Drawings.

3.02 REPAIR/RESTORATION

A. Per Section 40 05 01.

3.03 COMPONENT TEST PHASE

A. Buried Piping: Test hydrostatic pressure in accordance with Section 5 of AWWA C600, using the test pressures and allowable leakage specified in Section 40 05 01.

B. Exposed and Concrete Encased Piping: Conduct hydrostatic pressure tests in accordance with Section 40 05 01.

3.04 POLYETHYLENE ENCASEMENT

A. Install polyethylene as specified in AWWA C105 and within this Section.

B. Potable Water Pipe: Single wrap, 4-mil high density polyethylene.

C. Wrapping:
   1. Wrap buried pipe, fittings, valves, and couplings.
   2. Prior to the placing of concrete, wrap fittings that require concrete backing.
   3. Wrap the polyethylene tube seams and overlaps and hold in place by means of a 2-inch-wide plastic backed adhesive tape.
   4. The tape shall be such that the adhesive shall bond securely to both metal surfaces and polyethylene film.
   5. Bedding and initial backfill for polyethylene wrapped pipe shall be a well-graded granular material to avoid cutting or damaging the polyethylene tube during placement and backfilling.

END OF SECTION

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SECTION 40 05 23

STAINLESS STEEL PROCESS PIPE AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies stainless steel pipe and fittings.

1.02 RELATED SECTIONS

A. Section 40 05 01 – Piping Systems

B. Section 40 05 02 –Piping System Schedules

1.03 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B31.3	Process Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Requirements
ASTM A480	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
AWWA M11	Steel Pipe-A Guide for Design and Installation
AWWA C227	Bolted, Split-Sleeve Restrained and Non-Restrained Couplings for Plain-End Pipe
AWWA C606	Grooved and Shouldered Joints
CSA W48.3	Low Alloy Steel Covered Electrodes for Shielded Metal Arc Welding

1.04 SUBMITTALS

A. As required in Section 40 05 01 – Piping Systems.

B. Action Submittals:

1. Procedures: Section 01 33 00 – Submittal Procedures.
2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the CONTRACTOR, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The CITY shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the CONTRACTOR with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
3. Piping layout drawings as specified in Section 40 05 01– Piping Systems.
4. Manufacturers' product data, catalog cuts, typical installation details, and dimensions. Indicate on the submittal each piping system where the product will be used.
5. Pipe wall thickness calculations for pipe fabricated per AWWA C220. Demonstrate the maximum permissible internal design pressure in the pipe based on the wall/shell thickness specified in the Piping System Schedule for the associated Process Service and pipe size and the support and/or bedding conditions specified on the Drawings. Steel pipe design calculations conform to AWWA M11.
6. Pipe wall thickness and reinforcement calculations for fittings fabricated per AWWA C226. Demonstrate that the maximum permissible internal design pressure for fabricated fittings matches or exceeds the maximum permissible internal design pressure in the connecting pipe for the support and/or bedding conditions specified on the Drawings. Fabricated steel pipe fitting design calculations conform to AWWA M11.
7. Calculations for any pipe and fittings that are not fabricated per one of the components standards listed in the specified ASME B31 code.
8. Submit calculations for engineered flange face rings in accordance with Appendix D of ASME Section VIII Division 1.

C. Informational Submittals:

1. Procedures: Section 01 33 00.
2. Manufacturers' certificates of compliance with specified industry standards.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00 - Product Storage and Handling Requirements, for Shipment and Storage.

B. Deliver pipe and fittings with end protectors in place. Do not remove protectors until materials are about to be installed.

C. Prevent carbon steel contamination of stainless steel pipe and fittings during storage, handling, fabrication, and installation.

PART 2 PRODUCTS

2.01 MATERIALS

A. All pipe system materials to be new, free from defects and conforming to the requirements and standards specified in Piping System Schedules (Section 40 05 02.00 through Section 40 05 02.99) and this Section.

B. Pipe.
   1. Use pickled and annealed sheet or plate for manufacture of fabricated stainless steel pipe.
   2. Finish.
      a. 8-gage through 16-gage material: No. 1 or 2B per ASTM A480.
      b. 3/16-inch and heavier plate material: No. 1 mill finish per ASTM A480, "Hot-Rolled or Cold-Rolled, and Annealed or Heat Treated, and Blast Cleaned or Pickled."

C. Shop-fabricated stainless steel pipe and fittings.
   1. Furnished by a single manufacturer who is experienced and qualified in the manufacture and fabrication of the items to be provided.
   2. Manufacture using Weld Procedure Specifications (WPS) that have been qualified under ASME Section IX. Document qualifications in Procedure Qualification Reports (PQR). Use only certified welders who have successfully completed performance qualification tests per ASME Section IX for manufacture of stainless steel pipe.

D. Flanges.
   1. Stainless steel ring flanges, AWWA C228 Class SD minimum thickness.

   2. Stub ends.
      a. Wall thickness equal to or greater than pipe or fitting to which it is welded.
      b. Lap face/gasket mating surfaces clean, free of debris, with welds ground flush and surface roughness between 3.18 and 12.7 microns RMS.

E. Fittings.
   1. Double ferrule compression fittings capable of holding the full bursting pressure of connected tubing.
   2. Candidate manufacturers for double ferrule compression fittings.
      a. Swagelok.
      b. Gyrolok.
      c. Approved Equal.
   3. Provide straight tapered reducers. Flanged & flued reducers and bushing type adapters are not permitted.
   4. Pressure rating and thickness of elbows, tees, crosses, and wyes equal to or greater than connecting pipe.

F. Grooved couplings and fittings.
   1. Stainless steel flexible and rigid coupling with pipe grooves compliant with AWWA C606.
   2. When pipe wall thickness does not meet the minimum requirements of AWWA C606 for rolled or cut groove joints, provide shoulder ends per the requirements of AWWA C606.
   3. Candidate manufacturers.
      a. Victaulic
      b. Gruvlok
      c. Approved equal.

2.02 SHOP FABRICATION

A. Metal forming processes.
   1. Use pinch rolls with a hard chrome finish to form cylinders. Thoroughly clean the rolls using Avesta BlueOneTM 130 Pickling Paste or approved equal, prior to roll forming the pipe. Alternatively, provide a protective barrier between the stainless steel plate/sheet and the plate rolls during the forming process.
   2. Provide a protective barrier between pipe welding rollers and the stainless steel pipe cylinder. Alternately, new rollers or rollers that have been turned down on a lathe to provide a new and clean working face may be used.

B. All saws, drills, files, wire brushes, grinding wheels, etc. will be free of carbon contamination and designated for stainless steel use only.

C. Provide nonferrous, stainless steel, or rubber-lined pipe storage and fabrication racks.

D. Use nylon slings or straps for handling stainless steel piping.

E. Preparation of surfaces to be welded.
   1. Surfaces of joints to be welded are to be free from mill scale, slag, grease, oil, paint, rust, and other foreign material. Surfaces shall be descaled and cleaned in accordance with Paragraph 5 and Paragraph 6 of ASTM A380, respectively.
   2. Use only stainless wire wheels and grinding wheels that have not come into contact with carbon steel.
   3. Flame cutting or any use of oxy-acetylene gas cutting tools is prohibited. Use plasma arc torch with a nitrogen or argon-hydrogen carrier gas, laser or waterjet processes for cutting and plate beveling.
   4. Air arc and gas backgouging are prohibited. Use grinding and plasma gouging methods to achieve full penetration welds.

F. Welding.
   1. Welding and production processes are to conform to ASME B31.3.
   2. Use of Solar Flux is prohibited.
   3. Use of FCAW welding is prohibited.
   4. Pipe and fittings with wall thickness up to 11-gage (1/8-inch): weld using the GTAW process.

5. Pipe and fittings with wall thicknesses greater than 1/4-inch may be welded using an automated SAW process.
6. Pipe and fittings with wall thickness greater than 11-gage (1/8-inch): Bevel and complete root pass using the GTAW process, followed by subsequent passes with the GTAW, GMAW, or Metallic Arc SMAW process.
7. Filler material:
    a. Add only ELC wire grades to provide a cross section at the weld equal to or greater than the parent metal.
    b. SMAW electrodes to conform to CSA W48.3.
8. Make weld deposit smooth and evenly distributed and with a crown of no more than 1/16-inch on the I.D. and 3/32-inch on the O.D. of the piping. Concavity, undercut, cracks, or crevices are not permitted.
9. Full penetration butt welds: provide inert gas shielding to the interior and exterior of the joint.
10. Lap joints: provide full thickness seal welds on both joints.

G. Remove excessive weld deposits, slag, spatter, and projections by grinding. Grind welds smooth on gasket surfaces. Tack welds, clips, and other attachments.
    1. Repair nicks, gouges, notches, and depressions in the base metal in the area before the joint weld is made.
    2. Remove tack welds, clips, and other attachments and repair defects, except where the tack welds occur within the weld area and these tack welds do not exceed the size of the completed weld. Remove cracked tack welds.
    3. Grind those areas to be repaired down to clean metal and then repair by building up with weld metal. Grind the repaired areas smooth to form a plane surface with the base metal.

H. Defects and repairs.
    1. Remove welds with cracks, slag inclusions, porosity, undercutting, incomplete penetration, or which are otherwise deficient in quality or made contrary to any provisions of these specifications, by chipping or grinding throughout their depth to clean base metal.
    2. Do not perform calking or peening of welds to correct defects.
    3. Enlarge welds found deficient in dimension but not in quality by additional welding after thoroughly cleaning the surface of previously deposited metal and the adjoining plate.
    4. Remove weld deposits, slag, weld spatter, and projections into the interior of the pipe by grinding.

I. Finish.
    1. Clean and passivate in accordance with ASTM A380 or A967.
    2. Treat all welded joints with Avesta BlueOne™ 130 Pickling Paste or approved equal and rinse with clean water.
    3. If rusting of embedded iron occurs, pickle the affected surface with Avesta BlueOne™ 130 Pickling Paste or approved equal.
    4. Rinse clean using Avesta FinishOne Passivator 630 or approved equal.

5. Test all Stainless steel component surfaces in accordance with Paragraph 7.2.5 of ASTM A380. Testing to ensure proper passivation and cleaning has occurred shall be in accordance with Paragraph 7.2.5 of ASTM A380. First, perform a water-wetting and drying test on all stainless-steel surfaces in accordance with Paragraph 7.2.5.1 of ASTM A380. Failed areas shall be re-cleaned and retested using a Copper Sulfate Test in accordance with Paragraph 7.2.5.3 of ASTM A380. Any remaining failed areas shall be cleaned using a nitric acid solution in accordance with Table A2.1 Part II of ASTM A380 followed by retesting of all affected areas using a Copper Sulfate Test.

PART 3 EXECUTION

3.01 GENERAL

A. Field Installation Weather conditions.
   1. Perform welding only when the surfaces are clean and completely free of any moisture or mineral deposits. Protect pipe and fittings from salt water spray or deposition or clean and protect pipe and fitting joints prior to welding.
   2. Do not weld the pipe during periods of high winds or rain unless the areas being welded are properly shielded.

B. Field welding.
   1. Use couplings and prefabrication of pipe systems at the factory to minimize field welding to the greatest extent possible. Pipe butt welds may be performed at the job site, providing the butt welds are performed only with an inert gas shielded process and that the welding requirements of this Section are rigidly adhered to.
   2. On the interior and exterior of the pipe, remove all residue, oxide, and heat stain from any type of field weld and the affected areas adjacent by the use of stainless steel wire brushes, followed by cleaning with an agent such as Avesta BlueOne™ 130 or approved equal, followed by complete removal of the agent.

C. Use wooden scaffolding and/or ladders if possible to gain access to work areas. If metal scaffolding and/or ladders must be used, tape or otherwise shield the contact points between scaffolding/ladders and the stainless steel.

D. After installation, wash and rinse all foreign matter from the piping surface. Adhere to the passivation manufacturer's recommendations and local regulations for safety and disposal of any waste chemicals.

3.02 REPAIR/RESTORATION

A. Per Section 40 05 01 and as specified herein.

B. Paint all steel or iron flanges, couplings, and appurtenances in accordance with Section 09 90 00. Painting of the stainless steel pipe is not required.

C. Restore areas damaged or discolored by field welding or handling, iron contamination or soiled to a uniform surface finish and consistently clean surface with methods specified for shop fabrication.

D. Identifying spool piece marks shall be removed with paint thinner or solvents and the entire stainless steel surface shall be washed with detergent and hot water and rinsed clean.

3.03 COMPONENT TEST PHASE

A. Per Section 40 05 01.

END OF SECTION

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SECTION 40 05 24

STEEL PROCESS PIPE

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies steel pipe and fittings.

1.02 RELATED SECTIONS

A. Section 01 33 00 – Submittal Procedures

B. Section 01 66 00 – Product Requirements

C. Section 40 05 01 – Piping Systems

1.03 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.3	Malleable Iron Threaded Fittings, Class 150 and 300
ANSI B16.9	Factory-Made Wrought Steel Buttwelding Fittings
ANSI B16.11	Forged Steel Fittings, Socket-Welding and Threaded
ASTM A36/A36M	Structural Steel
ASTM A47	Ferritic Malleable Iron Castings
ASME B31.1	Power Piping
ASME B31.3	Process Piping
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A105/A105M	Forgings, Carbon Steel, for Piping Components
ASTM A106 REV A	Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A197	Cupola Malleable Iron

Reference	Title
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A283/A283M REV A	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
ASTM A536	Ductile Iron Castings
ASTM A570/A570M	Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
ASTM A572/A572M REV B	High Strength Low Alloy Columbium-Vanadium Steels of Structural Quality
AWWA C200	Steel Water Pipe 6 Inches and Larger
AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe--4 In. and Larger-- Shop Applied
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Services--Sizes 4 In. Through 144 In.
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold-Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA M11	Steel Pipe--A Guide for Design and Installation
SSPC-SP10	Near-White Blast Cleaning

1.04 SUBMITTALS

A. Action Submittals:

1. Procedures: Section 01 33 00
2. A copy of this specification section, addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations.
3. Manufacturers' product data, catalog cuts, installation details, and dimensions. Indicate each piping system that will use each steel pipe product or installation detail described in the Manufacturers' product data, catalog cuts, and installation details.
4. Pipe wall thickness calculations for pipe fabricated per AWWA C200. Demonstrate the maximum permissible internal design pressure in the pipe based on the wall/shell thickness specified in the Piping System Schedule for the associated Process Service and pipe size and the support and/or bedding conditions specified on the Drawings. Steel pipe design calculations conform to AWWA M11.
5. Pipe wall thickness and reinforcement calculations for fittings fabricated per AWWA C208. Demonstrate that the maximum permissible internal design pressure for fabricated fittings matches or exceeds the maximum permissible internal design pressure in the connecting pipe for the support and/or bedding conditions specified on the Drawings. Fabricated steel pipe fitting design calculations conform to AWWA M11.
6. Calculations for any pipe and fittings that are not fabricated per one of the components standards listed in the specified ASME B31 code.
7. Affidavits of Compliance with the provisions of AWWA C200, ASTM A53, API 5L or ASTM A106, as applicable for the specified pipe materials.

8. Product data for the following:
    a. Pipe:
        1) Material data.
        2) Chemical and physical test reports showing data consistent with specified requirements for each sheet or coil of steel proposed for use.
    b. Coatings and Linings:
        1) A list of the materials which indicates the manufacturer, product numbers, thickness, and recommended quality control testing procedures of the materials.
        2) Technical data sheets itemizing technical and performance information that indicates compliance with this Specification, and recommended application procedures.
        3) For each coating system, furnish a Safety Data Sheet (SDS).
        4) Color chart, if applicable.
        5) Manufacturer's name, product number or name, and thickness.
9. Layout Drawings shall be submitted and shall include the following: Pipeline layout showing stations and elevations, and details of standard pipe, joints, specials and fittings.

B. Information Submittals:
    1. Certificates:
        a. Certificate of Compliance that products furnished meet requirements of this Specification.
        b. Lining Materials: Certificate that lining system is currently approved for potable water contact in accordance with ANSI/NSF/CAN 61/600 and satisfies current applicable governmental health and safety requirements for use in potable water.
            1) Exception: Polypropylene lined piping is acknowledged as a commonly available material that is not required to be ANSI/NSF/CAN 60/600 certified under CDPHE regulations.
        c. Coating Materials: Certification that all work performed complies with the requirements of this Section and the appropriate AWWA standards. For all personnel applying tape to field joints, provide documentation of proper training by tape manufacturer's technical representative.
    2. Main Pipe Supplier (MPS)'s written Quality Assurance/Control (QA/QC) Plan.
    3. Reports:
        a. Source Quality Control Test Reports:
            1) Hydrostatic testing.
            2) Destructive weld testing.
            3) Nondestructive weld testing.
        b. Field Quality Control Test Reports:
            1) Weld tests, including re-examination of repaired welds, on each weld joint for the following tests, as applicable:
                a) Visual Testing (VT).
                b) Radiographic Testing (RT).
                c) Ultrasonic Testing (UT).

d) Magnetic Particle Testing (MT).
e) Liquid Penetrant Testing (PT).
f) Leak Testing (LT).

2) Applicator's quality control records, including environmental conditions, dry film thickness, and adhesion tests, when requested by Engineer.

c. Cement-mortar lining compressive strength tests in accordance with AWWA C205.

d. Cement-mortar coating absorption tests in accordance with AWWA C205.

4. Statements of Qualification:
   a. Pipe manufacturer.
   b. Fittings and specials fabricator.
   c. Welders or Welding Operators:
      1) Name of welder.
      2) Welding procedures/positions for which welder is qualified to weld.
      3) Assigned certification stamp number.
      4) Certification date.
      5) Current certification status.
   d. Certified Welding Inspector.
   e. NDT Quality Control Personnel.

C. Testing:
   1. Factory testing shall conform to the requirements of ASTM A53, ASTM A106, or AWWA C200 as applicable.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00 for Shipment and Storage.

B. Deliver pipe and fittings with stulling end protectors in place. Do not remove stulling or end protectors until materials are about to be installed.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel pipe and fittings shall be new, free from defects and provided in accordance with ASTM A53, ASTM A106, or AWWA C200, C208 as specified in Section 40 05 01.

B. Steel for pipe fabricated to meet requirements of AWWA C200 shall conform to the requirements of ASTM A36, ASTM A572, Grade 42, ASTM A570, Grades 33 and 36, or ASTM A283, Grade D. Steel for ASTM A53 and ASTM A106 pipe shall be Grade B.

C. Materials furnished shall be ANSI/NSF/CAN 61/600 approved for use with potable water.

2.02 PIPE MANUFACTURE

A. Unless otherwise specified, ASTM A53 pipe shall be Type E, electric resistance welded or Type S, seamless pipe as specified in Section 40 05 01. The minimum wall thickness for ASTM A53 or ASTM A106 pipe shall be Schedule 40 for pipe 10 inch diameter and less and 3/8 inch for pipe 12 inch through 24 inch diameter. Increased shell thickness shall be provided where specified.

B. AWWA C200 pipe shall be straight or spiral seam. The minimum wall thickness shall be 7 gage for pipe 6 inch through 24 inch diameter and 1/4 inch for pipe 26 inch diameter and larger. Increased shell thickness shall be provided where specified.

2.03 CONNECTIONS

A. Connections shall be as specified in Section 40 05 01 and shall conform to Section 40 05 06.16. Coating for buried connections shall be as specified in Section 40 05 06.16-2.06.

2.04 FITTINGS AND APPURTENANCES

A. Malleable iron threaded fittings and appurtenances shall conform to the requirements of ASTM A47 or ASTM A197, ANSI B16.3.

B. Unless otherwise specified, steel fittings and appurtenances shall conform to the requirements of ASTM A234, ASTM A105, or ANSI B16.11; and fabricated steel fittings and appurtenances shall conform to AWWA C208.

C. Fittings for grooved end piping systems shall be full flow cast fittings, steel fittings, or segmentally welded fittings with grooves or shoulders designed to accept grooved end couplings. Cast fittings shall be cast of ductile iron conforming to ASTM A536 or malleable iron conforming to ASTM A47. Standard steel fittings, including large size elbows, shall be forged steel conforming to ASTM A106. Standard segmentally welded fittings shall be fabricated of Schedule 40 carbon steel pipe.

D. Unless otherwise specified, all fittings shall be rated for pressure and loadings equal to the pipe.

2.05 PIPE LINING

A. Epoxy:
   1. Unless otherwise specified, pipe and fittings shall be lined with a liquid epoxy as specified in AWWA C210 with the following exceptions:
      a. No coal tar products shall be incorporated in the liquid epoxy.
      b. Line pipe and fittings with a liquid epoxy as specified in AWWA C210.
   2. The lining shall be applied to a minimum thickness of 16 mils in not less than two coats.

B. Cement Mortar:

1. Where specified, pipe and fittings shall be lined with cement mortar as specified in AWWA C205. Fittings and specials larger than 24 inches, not fabricated from centrifugally lined straight sections, shall require 2-inch by 4-inch by 13-gage self-furring wire mesh reinforcement for hand-applied lining.

C. High Temperature Service Epoxy:

1. Where specified, steel pipe and fittings shall be epoxy lined with not less than 10 mils of epoxy suitable for temperatures of 225 degrees F. Epoxy lining shall be 3M Scotchkote 306, Porter MCR 65 High Solids Epoxy, or equal. Surfaces shall be prepared in accordance with SSPC-SP 10 Near White Blast Cleaning, and the lining applied as recommended by the manufacturer.

D. Glass Lining:

1. Where specified, pipe and fittings shall be glass lined with a dual layer coating system of vitreous material to a minimum thickness of 10 mils. Glass lining shall provide continuous coverage as tested by a low voltage holiday detector with only isolated voids permitted due to casting anomalies. Voids, other than isolated pinholes, shall be cause for rejection.
2. Pipe and fittings shall have all internal welds ground smooth and any voids or slag holes ground out, rewelded and ground smooth.
3. Glass lining shall be Ferrock MEH-32, Vitco SG-14, or equal.

2.06 PIPE COATING

A. Apply coatings to steel pipe at the factory or fabrication shop. Unless specifically prohibited in this Section, repair of steel pipe coatings damaged after the pipe has left the factory or fabrication shop may be performed at the project site.

B. Acceptable Coating Systems

1. Epoxy:
   a. Unless otherwise specified, pipe and fittings shall be coated with a liquid epoxy as specified in AWWA C210 with the following exceptions:
   b. No coal tar products shall be incorporated in the liquid epoxy.
   c. The curing agent may be an amidoamine as well as the other curing agents listed in AWWA C210.
   d. The coating shall be applied to a minimum thickness of 16 mils in not less than two coats.
2. Polyethylene Tape:
   a. Coat and wrap pipe and fittings with prefabricated multilayer cold applied polyethylene tape coating in accordance with AWWA C209 and AWWA C214.
   b. Apply coating in a continuous step operation in conformance with AWWA C214, Section 3.
   c. The total coating thickness: not less than 50 mils for pipe 24-inch and smaller and not less than 80 mils for pipe 30-inch and larger.
   d. Patch field welds, connections and damaged in accordance with AWWA C209 and AWWA C214.

3. Polyurethane Coating.
    a. Coat pipe and fittings with polyurethane as specified in AWWA C222.
    b. Coating shall be self-priming, plural component, 100 percent solids, polyurethane, suitable for burial or immersion.
    c. Field joints shall be coated with heat-shrinkable polyolefin coatings. Pipe joints shall be field coated with heat-shrink sleeves after pipe assembly. Heat shrinkable coatings shall be applied as specified in AWWA C216.Field coating shall be compatible with the shop-applied coating system or shall be provided by the same manufacturer. Polyurethane coating system repair shall be in accordance with the coating manufacturer's recommended procedures.
    d. Coating material for repairs greater than 6 inches diameter shall be the same as the existing coating, or for repairs less than 6 inches diameter, repair coating as recommended by the polyurethane coating manufacturer, subject to approval. Repair coating shall have adhesion and performance characteristics equal to the existing coating.
    e. Patch field welds, connections and damaged coating in accordance with AWWA C222.
    f. Candidate manufacturers:
        1) Lifelast Durashield 210.
        2) Approved equal.

2.07 FUSION EPOXY COATING AND LINING

A. Where specified, steel pipe and fittings shall be fusion epoxy coated and lined. The fusion epoxy coating shall be 3M Scotchkote 203, or equal. Surface preparation shall be in accordance with SSPC-SP 10 Near White Blast Cleaning. The application method shall be by the fluidized bed method and shall attain 12 mils minimum dry film thickness.

B. Field welds, connections and otherwise damaged areas shall be coated and patched according to the manufacturer's instructions with 3M Scotchkote 306.

2.08 JOINT GASKETS

A. Joint gaskets shall be as specified in Section 40 05 06.13.

2.09 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
    1. Affidavits of Compliance with AWWA C200, ASTM A53, or ASTM A106 as applicable.
    2. Contractor's layout drawings as specified in Section 40 05 01-2.04.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Pipe shall be installed in accordance with AWWA M11, Chapter 16. Welded joints shall be in accordance with AWWA C206 and Section 40 05 06.16.
2. Sleeve-type mechanical pipe couplings shall be provided in accordance with AWWA M11 and Section 40 05 06.16-2.02 Sleeve-Type Couplings.
3. Pipe lining and coatings at field joints shall be applied as specified in paragraphs 2.05 and 2.06.
4. Unless otherwise specified, buried mechanical couplings and valves shall be field coated as specified in Section 40 05 06.16-2.06.

B. Anchorage:

1. Anchorage shall be provided as specified. Calculations and drawings for proposed alternative anchorage shall be submitted in accordance with Section 01 33 00.

3.02 REPAIR/RESTORATION

A. Per Section 40 05 01.

3.03 TESTING

A. Hydrostatic testing shall be in accordance with Section 4 of AWWA C600 except that test pressures and allowable leakage shall be as listed in Section 40 05 01.

END OF SECTION

SECTION 40 05 31.13

SOLVENT CEMENT WELDED PVC AND CPVC PRESSURE PIPE

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies Polyvinylchloride (PVC) and Chlorinated Polyvinylchloride (CPVC) pipe and fittings with solvent cement welded or threaded connections/joints.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 60 00 – Product Requirements
   3. Section 09 90 00 – Painting and Coating Systems
   4. Section 40 05 02 – Piping System Schedules

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASME B31.3	Process Piping
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2464	Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	Socket Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM D2855	Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
ASTM F402	Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings
ASTM F437	Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F438	Socket Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F439	Socket Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F493	Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
ASTM F656	Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic
ASTM F1970	Special Engineered Fittings, Appurtenances or Valves for use in Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Systems
AWWA C605-13	Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. PVC: Polyvinylchloride
   2. CPVC: Chlorinated Polyvinylchloride

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (✓) denote full compliance with a paragraph as a whole. Underline deviations and denote each deviation with a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification section along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Piping layout drawings as specified in Section 40 05 01.
   4. Manufacturer's product data, catalog cuts, typical installation details, and dimensions. Indicate each Piping System Schedule where the product will be used.

1.06 DELIVERY, STORAGE AND HANDLING

A. Procedures: Section 01 66 00 for shipment and storage.

PART 2 PRODUCTS

2.01 MATERIALS

A. Provide PVC and CPVC piping system materials as specified in Piping System Schedules (Section 40 05 02.00 through Section 40 05 02.99) for the specified Process Service.

2.02 COMPONENTS

A. All solvent weld cement and primer shall meet ANSI/NSF/CAN 61/600 standards for applications involving potable water.

B. All solvent weld cement and primer shall be specifically formulated for applications requiring chemical resistance to caustics, including but not limited to sodium hypochlorite, mineral acids and aqueous salt solutions.

C. CPVC/PVC Solvent Weld Cement:
   1. Pipe and fittings: IPS 724 Weld-on Cement or Approved Equal.
   2. Heavy bodied, medium setting.
   3. ASTM F493, 100 percent solvent and CPVC resin. No fillers permitted.
   4. Universal plastic pipe solvent is not acceptable.
   5. Formulated for use with sodium hypochlorite solution and other caustic solutions.

D. Primer:
   1. Staining solvent conforming to standard ASTM F656.
   2. Manufactured by solvent weld cement manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Join by means of socket fittings and solvent cement welding in conformance with ASTM D2855 and ASTM F402.

B. Make solvent-cemented joints in strict compliance with the manufacturer's/supplier's instructions and recommended procedures.

C. Connections:
   1. Connect to different pipe materials by means of flanges, specified adapters, or transition fittings.
   2. Provide threaded by solvent-welded socket joint adapters at connections to equipment and appurtenances with threaded connections.
   3. Foreign material to be removed from the pipe interior prior to assembly.

D. Plastic pipe installation personnel trained to ASME B31.3.

E. Bedding and Backfill: Per AWWA C605-13 Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings, and as specified in Section 31 21 33. Blocking under pipe is not permitted.

3.02 FIELD QUALITY CONTROL

A. Conduct hydrostatic pressure tests in accordance with Section 40 05 01.

END OF SECTION

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SECTION 40 05 31.19

CPVC DOUBLE CONTAINMENT PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies Chlorinated Polyvinylchloride (CPVC) pipe and fittings for double containment piping systems.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 60 00 – Product Requirements
   3. Section 40 05 02 – Piping System Schedules

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASME B31.3	Process Piping
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2464	Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	Socket Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM D2855	Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
ASTM F402	Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings
ASTM F437	Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F438	Socket Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F439	Socket Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F493	Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
ASTM F656	Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. PVC: Polyvinylchloride
   2. CPVC: Chlorinated Polyvinylchloride

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (✓) denote full compliance with a paragraph as a whole. Underline deviations and denote each deviation with a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification section along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Piping layout drawings as specified in Section 40 05 01.
   4. Manufacturer's product data, catalog cuts, typical installation details, and dimensions. Indicate each Piping System Schedule where the product will be used.
   5. Double containment piping system manufacturer's experience. Document years of experience manufacturing double containment piping systems.

1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Double containment pipe system manufacturer must have a minimum of five years' experience producing double containment pipe systems.

1.07 DELIVERY, STORAGE AND HANDLING

A. Procedures: Section 01 66 00 for shipment and storage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. The manufacturer's standard product may require modification to conform to specified requirements:
   1. IPEX Guardian Centra-Lok system.

2.02 MATERIALS

A. Furnish PVC, CPVC piping system materials, and PFA tubing material as specified in Piping System Schedules (Section 40 05 02.00 through Section 40 05 02.99) for the specified Process Service.

B. Carrier Pipe as specified in Piping System Specification Sheets.

C. Secondary Containment Pipe and Fittings: CPVC Pipe, ASTM D1784-Class 12454-B, NSF 61 certified, Dim. Per ASTM D1785.

2.03 COMPONENTS

A. Secondary Containment Fittings:
   1. Secondary Containment Fittings manufactured by the double containment pipe system manufacturer.
   2. Molded components. Materials per ASTM D184.

B. Carrier Pipe Support at Fittings:
   1. Match Carrier Pipe materials for Secondary Containment Supports at Fittings.
   2. Designed for field assembly of carrier pipe fittings in secondary containment fittings using self-centering, locking support clips.
   3. Carrier pipe fittings and secondary containment pipe fittings anchored together using support clips.
   4. Support clips consist of male by female, solvent weld, socket fittings with centering legs.
   5. Support clips must permit uninterrupted drainage along the invert of the secondary containment pipe.

C. Carrier Pipe Support Clips:
   1. IPEX Guardian Centra-Guide or approved equal.
   2. Carrier pipe supports to support and center the carrier pipe inside the secondary containment pipe.
   3. Carrier pipe supports must permit uninterrupted drainage along the invert of the secondary containment pipe.
   4. Provide carrier pipe supports at intervals recommended by the double containment system manufacturer.

D. Leak detection:
   1. Provide 24 VDC plastic encapsulated proximity type leak detections sensors consisting of an external clip-on sensor, drip leg, and drain valve with hose connection.
   2. Each sensor removable for periodic testing and provided with LED testing lamp and adjusting potentiometer.
   3. IPEX Guardian Centra-Guard or approved equal.
   4. Leak detection sensors mounted on the exterior of the secondary containment pipe using a saddle mount configuration.

5. Penetration of the secondary containment pipe is not permitted for leak detection sensor installations.
6. Install leak detection sensors at leak detection station locations indicated on the Drawings.
7. Slope pipe system down toward leak detection stations.
8. Provide NEMA 4X FRP control panel with leak detection sensitivity adjustment and 24 VDC SPDT general alarm relay switch for communication with the plant control system.
9. Consolidate leak detection sensors at each cluster of leak detection wells into a single control panel.

E. CPVC Solvent Weld Cement:
1. Pipe and fittings 6-inch diameter and smaller: IPS 724 Weld-on Cement or Approved Equal.
2. Pipe and fittings greater than 6-inch diameter: IPS 729 Weld-on Cement or Approved Equal.
3. Heavy bodied, medium setting.
4. ASTM F493, 100 percent solvent and CPVC resin. No fillers permitted.
5. Universal plastic pipe solvent is not acceptable.
6. Formulated for use with sodium hypochlorite solution and other caustic solutions.

F. PVC Solvent Weld Cement:
1. Pipe and fittings 12-inch diameter and smaller: IPS 711 Weld-on Cement or Approved Equal.
2. Pipe and fittings greater than 12-inch diameter: IPS 719 Weld-on Cement or Approved Equal.
3. Heavy bodied, medium setting.
4. ASTM 2564, 100 percent solvent and PVC resin. No fillers permitted.
5. Universal plastic pipe solvent is not acceptable.

G. Primer:
1. Staining solvent conforming to standard ASTM F656.
2. Manufactured by solvent weld cement manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Solvent Cement Welded PVC and CPVC Pipe:
1. Join by means of socket fittings and solvent cement welding in conformance with ASTM D2855 and ASTM F402.
2. Make solvent-cement welded joints in strict compliance with the manufacturer's/supplier's instructions and recommended procedures.

B. Connections:
1. Connect to different pipe materials by means of flanges, specified adapters, or transition fittings.

2. Foreign material to be removed from the pipe interior prior to assembly.

C. Plastic pipe installation personnel trained to ASME B31.3.

D. Bedding and Backfill: As specified in Section 31 23 00. Blocking under pipe is not permitted.

3.02 FIELD QUALITY CONTROL

A. Carrier Pipe Testing: Conduct hydrostatic pressure tests in accordance with Section 40 05 01.

B. Secondary Containment Pipe Testing: Pneumatic Test.
   1. Medium: Instrument Grade Air or Nitrogen.
   2. Test Pressure: 5 psig maximum.
   3. Duration: 2 hours.
   4. Maximum Allowable Pressure Drop: 0.1 psig over 2 hours.
   5. Maintain 10 psig, minimum, in primary containment pipe during testing of secondary containment pipe.
   6. Test Safety: As specified in Section 40 05 01for Pneumatic Pressure Testing.
   7. Conform to double containment pipe system manufacturer's compressed gas testing procedures.

END OF SECTION

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SECTION 40 05 33.13

HIGH DENSITY POLYETHYLENE PIPE - SOLID WALL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Heat fusible, uniform thickness, solid wall, constant outside diameter, high-density polyethylene (HDPE) pressure pipe, fittings, and appurtenances.
   2. This Section does not specify HDPE pipe with a corrugated, tubular, or structured wall profile.
   3. This Section applies to all piping defined in Section 40 02 01.13, which pertains to all piping included with the Water Treatment Plant and associated yard piping within the vicinity of the plant unless otherwise defined on the drawings. Refer to Section 33 05 36 for all other HDPE piping.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 31 23 00 – Excavation, Trenching, and Backfill.
   2. Section 40 05 01 – Piping Systems.
   3. Section 40 05 02 – Piping System Schedules.
   4. Section 40 05 07 – Pipe Hangers and Supports.

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.
   1. ANSI/AWWA C901 – Polyethylene (PE) Pressure Pipe and Tubing, 3/4-inch through 3 inch, for Water Service.
   2. ANSI/AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4-inch through 63-inch, for Water Distribution.
   3. AWWA M-55 - PE Pipe – Design and Installation.
   4. ASTM D2321 - Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
   5. ASTM D2513 - Polyethylene Gas Pressure Pipe, Tubing, and Fittings.
   6. ASTM D2657 - Heat Joining Polyolefin Pipe and Fittings.
   7. ASTM D2774 - Underground Installation of Thermoplastic Pressure Piping.
   8. ASTM D3035 – Polyethylene Plastic Pipe Based on Controlled Outside Diameter.
   9. ASTM D3261 - Butt Heat Fusion Polyethylene Plastic Fittings for PE Plastic Pipe and Tubing.
   10. ASTM D3350 - Polyethylene Plastics Pipe and Fitting Materials.

11. ASTM F1055 - Electrofusion Type Polyethylene Fittings for OD Controlled PE Pipe and Fittings.
12. ASTM F1668 - Construction Procedures for Buried Plastic Pipe.
13. ASTM F2164 - Standard Practice for Field Leak Testing of Polyethylene Pressure Piping Systems Using Hydrostatic Pressure.
14. ASTM F2206 - Fabricated Fittings of Butt-Fused Polyethylene.
15. ASTM F2620 - Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.
16. ASTM F714 - Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.
17. PPI TR 31 - Underground Installation of Polyolefin Piping.

1.04 SUBMITTALS

A. Procedures: Section 01 33 00 – Submittal Procedures.

B. As required in Section 40 05 01 – Piping Systems.

C. Action Submittals:
   1. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations.
   2. Qualifications of the certified fusion technician.
   3. Piping layout drawings as specified in Section 40 05 01 – Piping Systems and as indicated on the Drawings.
   4. Manufacturers' product data, catalog cuts, typical installation details, and dimensions. Indicate each piping system where the product will be used on the submittal.
   5. Pipe Manufacturers' joint assembly procedure.

D. Informational Submittals:
   1. Procedures: Section 01 33 00 – Submittal Procedures.
   2. Records of each field butt-fusion joint installation, as specified in this specification.
   3. Manufacturer's affidavit affirming that the materials furnished for the project comply with the standard specified in the Piping System Schedules (Section 40 05 02.00 through 40 05 02.99).

1.05 QUALITY ASSURANCE

A. Qualifications: Field welding by butt fusion and/or electrofusion performed by a factory trained and certified fusion technician. Training and/or certification by fusion equipment manufacturer or pipe manufacturer.

B. Certifications: Furnish affidavit (as specified in AWWA C901 and AWWA C906) documenting compliance AWWA C901 and/or AWWA C906, as appropriate for the pipe material specified in the Piping System Schedules (Section 40 05 02.00 through 40 05 02.99).

1.06 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00 – Product Storage and Handling Requirements.

B. Store on clean, level ground to prevent undue scratching or gouging of the pipe. If the pipe must be stacked for storage, stack in accordance with the pipe manufacturer's recommendations.

C. Prevent damage to pipe from dragging over sharp objects or cutting by chokers or lifting equipment while handling pipe.

D. Handle pipe in accordance with pipe manufacturer's recommendations.

E. Pipe with gouges, cuts, or scratches deeper than 10% of the pipe wall thickness will be rejected.

F. Pipe with cuts, gouges, and/or scratches of the pipe interior will be rejected.

G. Store pipe in accordance with pipe manufacturer's recommendations until installation.

H. Store pipe at ambient outdoor temperature.

I. Provide temporary shading.

J. Avoid coverings that will raise pipe temperature over ambient temperature.

PART 2 PRODUCTS

2.01 MATERIALS

A. All pipe system materials to be new, free from defects and conforming to the requirements and standards specified in this identified in the Piping System Schedules (Section 40 05 02.00 through 40 05 02.99).

B. Pipe Color:
   1. Black.
   2. Where specified in the Piping System Schedules (Section 40 05 02.00 through 40 05 02.99), provide co-extruded longitudinal color stripes equally spaced around the circumference of the pipe. Stripe color as specified in the Piping System Schedules.

C. Fittings:
   1. Provide ARC™ long radius sweep bends manufactured by Pipestar International, or approved equal, for 2-inch through 14-inch long radius bends. Bend radius 3 times the nominal pipe size, measured to the centerline of the bend.
   2. Increase wall thickness to next nominal pressure rating (next lower SDR) for mitered bends and fabricated fittings. 2 miter segments, minimum for deflections of 45 degrees or less. 4 miter segments, minimum for deflections greater than 45 degrees.

D. Flange Ends:
   1. HDPE stub end flange adapter and back up ring.

2. Furnish beveled flange adapters for disk clearance on flanged connections to butterfly valves.
3. Furnish stub end flange adapters with radius or chamfered outer diameter transition from pipe wall to stub end.
4. Chamfer or radius flange ring bore to match transition on stub end flange adapter.
5. Ductile iron back up rings encapsulated in polypropylene or CF8 (304) Stainless Steel back up rings: Improved Piping products – PPDI, Improved Piping Products - SS-SDR, or approved equal.

E. Couplings:
1. HPEG – HDPE Plain End with Gripping Teeth.
a. HPEG couplings consist of two coupling halves, gasket, and gripping teeth that engage and grip the exterior of plain end HDPE pipe segments.
b. HPEG (HDPE Plain End with Gripping Teeth): Victaulic Style 995N, Victaulic Style 905, or Approved Equal.

PART 3 EXECUTION

3.01 INSTALLATION, EXPOSED AND SUBMERGED

A. Install piping system in accordance with Chapter 8 of the Plastic Pipe Institute *PE Handbook*, ASTM F2620, AWWA C901 or AWWA C906, and the manufacturer's recommendations.

B. Joining:
1. Butt fusion welds in accordance with the pipe manufacturer's recommendations and ASTM D2657.
2. Obtain optimum fusion parameters from the pipe manufacturer, with regard to fusion temperature, interface pressure, and cooling time.
3. Follow the manufacturer's recommendations with regard to the optimum fusion parameters, and use proper equipment for the fusion process.
4. Butt fusion joint strength exceeds tensile strength of pipe.
5. Extrusion welding and hot gas welding is not permitted.
6. Pipe joints completed by factory trained and certified fusion technicians.
7. Provide flange joints for connections to different pipe materials, equipment, valves, and other appurtenances unless otherwise specified on the Drawings.
8. Provide flange joints for long radius sweep bend fittings.
9. Install electrofusion welds where required for closures and joining HDPE to fixed/installed HDPE pipe or where specified on the drawings. Install electrofusion welds per the manufacturer's instructions and ASTM-F1055.

C. Pipe Support:
1. Conform to Section 40 05 07-- Hangers and Supports for Process Piping.
2. Accommodate thermal expansion and contraction movement, per Section 40 05 07.16 – Expansion Control for Piping.
3. Support pipe at intervals of 8 feet or less.
4. Provide pipe cradles supporting the bottom 120 degrees of pipe circumference.

5. Cradle length (measured parallel to pipe axis) not less than half of the pipe's outside diameter.
6. Edges of pipe cradles rounded or rolled to prevent cutting or gouging pipe.

3.02 SYSTEMS START UP

A. Procedures: Section 01 45 23 – Testing and Inspection Services.

B. Pressure Testing:
1. Pressure test pipe per Section 40 05 01 – Piping Systems
2. Install pipe supports, anchors, seismic bracing, and flexibility provisions prior to pressure testing.
3. Perform pressure testing prior to encasement in concrete or backfilling buried pipe.
4. Retest following repair of leaks.
5. Apply initial pressure without makeup pressure for 1-2 hours to allow for diametric expansion or pipe stretching to stabilize.
6. After the equilibrium period, restore the test section to the test pressure.
7. Makeup water quantities during the pressure test per the Plastic Pipe Institute Technical Report TR 31-88. No visual leaks or pressure drops permitted during the final test period.

END OF SECTION

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SECTION 40 05 45

PIPING SYSTEM IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies the supply and installation of permanent identification labels and markers for piping systems.

B. Requirements for the supply and installation of permanent identification tags for valves are specified in Section 40 05 60.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.

B. Section 01 33 00 – Submittal Procedures

C. Section 01 45 00 – Area Exposure Designations

D. Section 40 05 02 – Piping System Schedules

E. Section 40 05 60 – Valves

1.03 REFERENCES

A. References:

B. This section contains references to the documents listed below. They are a part of this section as specified and modified. Where a referenced document cites other standards, such standards are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

C. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, has been discontinued or has been replaced.

Reference	Title
ASME A13.1	Scheme for the Identification of Piping Systems
ANSI Z535.1	Safety Colors/APWA Uniform Color Code for Marking Underground Utilities

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:

B. Embedded/Encased piping: Piping enveloped in concrete, typically under structures or under roadways.

C. Exposed: All area exposures specified in Section 01 45 00 other than buried, submerged, or encased/embedded.

D. Buried: Below grade walls or roofs; locations covered and in contact with earth/soil.

1.05 SUBMITTALS

A. Action Submittals:

B. Procedures: Section 01 33 00.

C. Provide a full line product brochure showing available Piping System Marker and Detectable Warning Tape standard text and color options. Submit all text and colors proposed for use.

D. Provide manufacturer's recommended installation instructions for Detectable Warning Tape.

E. Provide product brochures and data sheets for tracer wire and splice kits. Submit all wire insulation colors proposed for use.

F. Submit proposed tracer wire access box(es) for test leads. Submit electrical continuity test results upon completion.

G. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from Section requirements.

H. Informational Submittals:

I. Procedures: Section 01 33 00

J. Electrical continuity test results.

K. Sample of each piping identification plastic marker used.

L. Sample of each detectable warning tape used.

PART 2 PRODUCTS

2.01 PIPING SYSTEM MARKERS FOR EXPOSED PIPE

A. Identify material contained in exposed piping systems using a colored plastic marker legend system conforming to ASME A13.1.

B. For exposed piping, provide pre-coiled mechanically attached type colored markers that are easily removable. Adhesive type markers are not acceptable.

C. Resistant to petroleum based oils and grease and meet criteria for humidity, solar radiation, rain, salt, fog, leakage and fungus specified by MIL-STD-810.

D. Withstand a continuous operating temperature range of -40 to 250 degrees.

E. Manufactured and applied in one continuous length of plastic including directional arrows. Markers comprised of letters and directional arrows individually applied to the maker are not acceptable. Legends and arrows printed on polyester subsurface and over laminated with Tedlar.

F. Text size per ASME A13.1.

G. Marking Services Style MS-995, Brady Style B-689, or approved equal.

H. Each piping system marker to be color coded for identification and labelled with the Process Service Identifier and directional flow arrows indicating the direction of flow in the pipe. Piping System marker background colors are specified in Section 40 05 02 for each process service. Except for piping system markers with an orange, yellow or white background color, provide white text and directional arrows for all piping system markers. Provide black text and directional arrows for pipe markers with an orange, yellow or white background.

2.02 DETECTABLE WARNING TAPE AND TRACER WIRE FOR BURIED PIPE

A. Provide Detectable Warning Tape for all buried piping:
   1. Detectable Warning Tape shall be 6 inches wide, colored per ANSI Z535.1 (APWA Uniform Color Code for Marking Underground Utilities) and made of inert plastic material suitable for direct burial with solid aluminum foil core. Minimum 5 mil laminate thickness. Tin or nickel plated clips for joining sections of tape, as provided by the tape manufacturer.
   2. Allen Systems, W. H. Brady Co., Seton Name Plate Corporation, Marking Services Inc., or approved equal.
   3. Print two messages on buried Detectable Warning Tape. The first message reads **"CAUTION CAUTION CAUTION _____ PIPE BURIED BELOW"** with bold letters approximately 2 inches high. Fill the blank with the Process Service name. The second message reads **"CALL____"** with letters approximately 3/4 inch high. Both messages printed at maximum intervals of 2 feet. Fill the blank with phone number provided by the Construction Manager.

B. Install tracer (locate) wire along the buried portion of pipe alignments for all piping designated as Indoor – Buried [Includes Embedded and Encased] and Indoor – Buried [Embedded and Encased] in Section 40 05 02.

C. Direct burial rated, 12 gauge solid copper, 600-volt UF tracer wire with heavy-duty PVC insulation. Tracer wire insulation color-coded to match each utility service as designated in ANSI Z535.1 (APWA Uniform Color Code for Marking Underground Utilities).
   1. SPLICES: Silicone-filled UL-Listed product specifically designed for waterproof direct bury splicing of tracer wire. 3M DBR-6; or approve equal.

2. WIRE ACCESS BOXES: Cast iron valve box top piece frame and cover set within a concrete ring cast flush with grade, as appropriate for the location in which it will be installed and for the traffic loading it may be subject to, and in accordance with the applicable elements of the Standard Detail for valve box installations. Mark lids in raised or recessed lettering with the word "Test". Submit all wire access boxes proposed for use to the Construction Manager for review.

PART 3 EXECUTION

3.01 INSTALLATION OF PIPING SYSTEM MARKERS

A. Provide piping system markers and direction arrows at locations conforming to ASME A13.1 and at the following locations:
   1. Apply intermittent markings on straight pipe runs, close to all valves, fittings, and adjacent to all changes in direction.
   2. Where pipes pass through walls, partitions, and floors, apply markings on both sides of walls, partitions, and floors.
   3. At point of entry and leaving each pipe chase and/or confined space, and piping accessible at each access opening.
   4. Adjacent to valves and where valves are in series at intervals of no more than 6 feet.
   5. At least once in each room and at maximum spacing of 40 feet. Exception: gas piping to be identified at 6-ft intervals in ceiling plenums.
   6. Spacing for markings not less than 1 foot.
   7. At the beginning and end points of each run; and, at each piece of equipment in each run.

B. Visibility
   1. Place identification on the bottom of the piping system for pipe systems located near ceiling or above the normal line of sight.
   2. Place identification on the side of the piping systems for pipe systems located at the normal line of sight or below.
   3. Place identification at approximate line of sight for vertical pipe systems.

3.02 INSTALLATION OF DETECTABLE WARNING TAPE

A. Install a continuous ribbon of Detectable Warning Tape as specified for ALL buried piping.

B. Multiple pipes less than 4 inches in diameter installed in a common trench may be provided with a single ribbon of tape per trench. If the total width of such utilities within the common trench exceeds 3 feet, provide two parallel ribbons of tape spaced equally.

C. Provide a separate detectable warning tape for each pipe that is 4 inches or greater in size.

D. Install the tape in accordance with manufacturer recommendations.

E. At end-to-end and branch connections, provide electrical continuity connectors for detectable tape to mechanically and electrically connect ends together as recommended by the manufacturer.

1. Provide a single line of tape 2.5 feet above the centerline of buried pipe. For pipelines buried 8 feet or greater below finished grade, provide a second line of tape 12 inches below finished grade, above and parallel to each buried pipe. Spread tape flat with message side up before backfilling.

3.03 INSTALLATION OF TRACER WIRE

A. Tracer wire shall be a continuous, fully functioning, and tested system to include all appurtenances including splices and wire access boxes at grade.

B. Tracer wire laid along the top of the pipe prior to backfilling. Secure in place with tape every 20 feet. Where the pipe is encased or provided with concrete collars or cut-off walls, lay the wire on top of the encasement (do not encase the wire). Do not pull the wire taut; leave sufficient slack to allow for pipe movement and future repairs.

C. Splice tracer wire using the specified silicone-filled splice kits in accordance with manufacturer recommendations. Ensure the silicone fully encapsulates un-insulated wire ends and are made watertight.

D. Pull tracer wire up into all valve boxes, cleanout access boxes, and into all utility cabinets and meter boxes installed on the pipeline. For each wire end, provide an 18-inch long length of extra wire (coiled and tucked out of the way in an accessible location) for connection to utility locating equipment.

E. Where the pipeline enters structures, vaults, tanks, or buildings, provide a wire access box at grade adjacent to the structure or building for termination of the tracer wire. Provide an 18-inch long length of extra wire (coiled and tucked into the box) for connection to utility locating equipment. Also provide boxes at each pipeline branch, cross or tee, and at intermediate spacing along the pipeline not to exceed 1,000 feet (except where pipeline valves with valve boxes provide the required wire access at those locations and intervals).

F. Upon completion and backfill of the pipeline, test and demonstrate electrical continuity of each segment of tracer wire. Submit test results to the Owner indicating the location of the tested segment. Use conductive testing method; inductive test methods are not acceptable. Repair all faulty work at no additional cost to the Owner until the system is functional and approved.

3.04 FIELD QUALITY CONTROL

A. Comply with manufacturer's handling and installation instructions.

B. Provide continuity testing of tracer wire as specified herein.

END OF SECTION

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SECTION 40 05 57.13

MANUAL ACTUATORS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies manual operators for valves and gates, and operator appurtenances.

1.02 REFERENCES

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AWWA C500	Gate Valves 3 through 48 inch NPS, for Water and Sewage Systems

PART 2 PRODUCTS

2.01 GENERAL

A. Except as specified in valve and gate specification sections, manual operators shall be as specified herein. Operators shall be mounted on the valve or gate and provided as a unit. Each valve body or operator shall have cast thereon the word "OPEN," an arrow indicating the direction to open, and flow direction arrows.

2.02 OPERATORS

A. General:
   1. Manual operators shall have operating torques less than 80 foot-pounds. Unless specified otherwise, each manual operator shall be provided with an operating wheel. Unless specified otherwise, the direction of rotation of the operator shall be counterclockwise for opening.

B. Wrench Nuts:
   1. Wrench nuts shall comply with Section 3.15 of AWWA C500. A minimum of two operating keys, but no less than one key per every ten valves, shall be provided for operation of the wrench nut operated valves.

C. Chain Wheels:
   1. Chain wheels shall be ductile iron. Operating chains shall be galvanized.

2.03 OPERATOR APPURTENANCES

A. Valve Boxes:
   1. Valve boxes shall be cast iron and shall have suitable base castings to fit properly over the bonnets of their respective valves and heavy top sections with stay-put covers. Covers shall be hot-dip galvanized.

B. Floor Boxes:
   1. Floor boxes shall be hot-dip galvanized. Where the operating nut is in the concrete slab, the floor box shall be bronze bushed. Where the operating nut is below slab, the opening in the bottom of the box shall be sufficient for passage of the operating key.

C. Adjustable Shaft Valve Boxes:
   1. Adjustable shaft valve boxes shall be concrete or cast iron Brooks No. 3RT, Christie G5, Empire 7-1/2 valve extension box, or equal. Box covers on water lines shall be impressed with the letter "W."

2.04 PRODUCT DATA

A. Manufacturer's catalog information and other data confirming conformance to design and material requirements shall be provided in accordance with Section 01 33 00.

PART 3 EXECUTION

3.01 GENERAL

A. Installation shall be as specified herein. Valve operators shall be located so that they are readily accessible for operation and maintenance. Valve operators shall be mounted for unobstructed access, but mounting shall not obstruct walkways. Valve operators shall not be mounted where shock or vibration will impair their operation. Support systems shall not be attached to handrails, process piping, or mechanical equipment.

3.02 OPERATORS

A. General:
   1. Valves and gates shall be provided with manual operators, unless specified otherwise. Where possible, manual operators shall be located between 48 inches and 60 inches above the floor or a permanent work platform.

B. Wrench Nuts:

1. Wrench nuts shall be provided on buried valves, on valves which are to be operated through floor boxes, and where specified. Extended wrench nuts shall be provided if necessary so that the nut will be within 6 inches of the valve box cover.

C. Chain Wheels:

1. Unless otherwise specified, valves with centerlines more than 7 feet, 6 inches above the specified operating level shall be provided with chain wheels and operating chains. Chain wheel operated valves shall be provided with a chain guide. Operating chains shall be looped to extend within 4 feet of the specified operating level below the valve. For plug-type valves 8 inches and larger, the operator shall be provided with a hammer blow wheel. Hooks shall be provided for chain storage where the chain may hang in a walkway.

3.03 OPERATOR APPURTENANCES

A. Valve Boxes:

1. Valve boxes extending to finished surfaces shall be provided for buried valves.

B. Floor Boxes:

1. Floor boxes shall be provided for wrench operation of valves located below concrete slabs. Each floor box and cover shall be of the depth required for installation in the slab.

END OF SECTION

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SECTION 40 05 57.23

POWERED ACTUATORS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes requirements for electric motor actuators to produce rotary and linear motion to activate quarter-turn and multi-turn valves and gates in open-close, throttling, and modulating services.

1.02 REFERENCES

A. This Section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this section prevail.

Reference	Title
ANSI/AWWA C542-09	Electric Motor for Valves and Slide Gates.
ANSI/NEMA 250	Enclosures for Electrical Equipment (1,000 Volts Maximum).
ANSI/NEMA MG1	Motor and Generators.
ANSI/NFPA 70	National Electrical Code.
UL 429	Electrically Operated Valves.
UL 1002	Electrically Operated Valves for Use in Hazardous (Classified) Locations.

1.03 DEFINITIONS

A. Use ANSI/AWWA C542-09, Electric Motor Actuators for Valves and Slide Gates definitions, unless otherwise noted.

B. For purposes of this Section, the word "valve" refers to both valves and gates.

C. Electric motor actuators are defined using the following code system which appears in the actuator specification (ACTUSPEC) sheets:

Actuator Type			Actuator Features	
Category	Motion	Service	Power Supply	Fail Position
X	X	X	-PS	-Z
• E = Electric	• QT = Quarter-Turn • MT = Multi-Turn	• I = Isolating (Open-Close) • T = Throttling • M = Modulating	• 480V = 480 V AC, 3 phase, 60 Hz • 120V = 120 V AC, 1 phase, 60 Hz • 24V = 24 V DC	• Blank = Last • O = Open • C = Closed

D. Service:

1. Modulating: Operation characterized by the continuous positioning of a valve between fully open and closed, in response to a continuous control signal.

2. Open-Close: To move valve to fully open or fully closed position in one continuous operation. Alternative terms used are ON-OFF and isolating.
3. Throttling: Operation characterized by the deliberate and/or the infrequent movement of a valve to an intermediate position, between fully open and fully closed, and maintaining that position for periods of time.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Unit Responsibility:
   1. Provide unit responsibility, as specified in Section 43 05 11, and the electric motor actuator specified in this section.
   2. Provide a completed and signed Unit Responsibility Certification Form (Form 46 05 11-C, Section 01 99 90).

B. Coordination:
   1. Data: Ensure the valve data is provided to the actuator manufacturer. Transmit the required torque or thrust, shaft diameter, thread characteristics (including right or left-hand), keyway dimensions, seating requirements (torque or position) for open and close.
   2. Conditions: Identify most adverse conditions to be encountered at any time when actuation is necessary.
      a. For multi-turn, the following additional data is required for actuator sizing:
         1) Maximum torque and thrust running load over the full cycle.
         2) Desired speed of actuation or stroking time.
         3) The stall torque or maximum thrust output of the actuator not to exceed the torque or thrust capability as determined by the valve manufacturer.
      b. For quarter-turn, the following additional data is required for actuator sizing:
         1) The required actuator torque over the full cycle of operation.
         2) Desired speed of actuation or stroking time.

1.05 SUBMITTALS

A. Procedures: Section 01 33 00.

B. Action Submittals.
   1. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from Section requirements.
   2. A copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this Section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, mark the drawing or drawings with "no changes required".
   3. Manufacturer's catalog information and other data confirming conformance to design and material requirements.

4. Actuator Data Sheet: An information data sheet for each actuator showing required mounting, operating torque for driven equipment, torque capacity of actuator, actuator speed, associated valve torque ratings, motor data (power, hp; full load amps, locked rotor amps, rpm, duty rating). Provide actuator identification (tag) number clearly for each application on the actuator data sheet.
5. List of components being provided for each actuator.
6. Shop drawings:
    a. Actuator assembly.
    b. Dimensions.
    c. Electrical wiring diagrams.
7. Actuator sizing report correlating to the coupled valve or gate type, operating torque, and specified safety factor.

C. Informational Submittals:
1. Application software and software manuals for configuring and set up of actuator for control, monitoring and alarming.
2. Recommended storage practice. In addition, place this information on the outside of the actuator or shipping container as delivered to the site.

D. Closeout Submittals:
1. Operation and Maintenance Data:
    a. Submit manufacturer's standard operating and maintenance instructions as specified in Section 01 78 23.
    b. Include final reviewed submittal.
    c. Actuator Configuration Settings: The final settings used for configuration of the actuator to meet field operation requirements. Include both the electronic files and a hard copy printout in pdf format.
2. Training Certification Section 43 05 11-Form B.
3. Maintenance Material:
    a. Spare Part Inventory Listing.
    b. Spare Parts.
    c. Special Tools.
    d. Lubrication guide.
    e. Certified drawings.

1.06 QUALITY ASSURANCE

A. Identification of Listed Products:
1. Provide equipment and materials listed for the purpose for which they are to be used, by an independent testing laboratory. Three such organizations are Underwriters Laboratories (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). Provide independent testing laboratory acceptable to the inspection authority having jurisdiction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Candidate manufacturers are specified on the actuator specification (ACTUSPEC) sheets. The manufacturer's standard models or products may require modification to conform to the specified requirements.

2.02 PERFORMANCE

A. Size actuators to produce an operating torque equal to twice the maximum required valve operating torque under the specified flow and pressure conditions. Specific requirements for each type of actuator are specified on the actuator specification (ACTUSPEC) sheets located at the end of this Section.

B. Seat valve or stopping method based on valve manufacturer's recommendation:
   1. Torque
   2. Position/Limit

C. Ambient Temperature Range: -20-to-+140-degree Fahrenheit (up to 100% relative humidity).

D. Rotation:
   1. Quarter-Turn: 90 degrees, with +/- 5-degree adjustable mechanical travel stops. Stops designed to withstand maximum actuator torque.
   2. Multi-Turn: Position setting range of 2.5 to 8,000 turns with a minimum angular resolution of 7.5 degrees at the output.

2.03 CONFIGURATION, COMPONENTS AND FEATURES

A. General: Unless otherwise specified, provide electric motor actuators in accordance with the actuator specification (ACTUSPEC) sheets and the following requirements.

B. Motor:
   1. General:
      a. Specifically designed for valve actuator service.
      b. Totally enclosed, non-ventilated construction.
      c. Compliance to ANSI/NEMA MG1.
   2. Duty Rating based on Actuator Service:
      a. Modulating: 50% (30 minutes) or 100% (continuous) duty motor rated for minimum of 900 starts per hour.
      b. Open-Close: 25% (15 minutes) or 50% (30 minutes) duty motor rated for minimum of 60 starts per hour.
      c. Throttling: 25% (15 minutes) or 50% (30 minutes) duty motor rated for minimum of 60 starts per hour.
   3. Motor Starter: Provide actuator with a full voltage reversing starter rated for the motor's locked rotor and full load currents for 10,000 cycles with mechanical and electrical interlocks and overload protection in each phase pole.

4. Three Phase:
    a. Reversible, Squirrel Cage Motor.
        1) 460 volt, 3 phase, 60 hertz power with +/- 10 percent voltage fluctuation.
        2) Four-pole 1800 RPM or provide pole-speed as required for the application.
        3) NEMA Class F insulation.
        4) Thermistor or thermostat for thermal protection embedded in the motor windings.
        5) Automatic motor thermal reset once motor has cooled sufficiently after overload.
        6) Three conduit openings, minimum.
    b. Control Transformer:
        1) Epoxy encapsulated and impregnated with short-circuit and overload protection.
        2) Rated, at a minimum, to handle 80 percent of the connected load with 120 VAC secondary or other secondary voltage of 24 VDC as required.
        3) Adequately rated to provide power for the following functions:
            a) Energizing of the contactor coils.
            b) Internally sourced power for remote controls.
            c) Internal electrical circuits.
            d) Heater.
5. Single Phase (AC):
    a. Reversible, Capacitor Induction Motor.
        1) 120 volt, 1 phase, 60 hertz power with +/- 10 percent voltage fluctuation.
        2) NEMA Class B or F insulation.
        3) Thermal overload protection with automatic reset
        4) Two conduit openings, minimum.

C. Enclosure: Provide NEMA 250 electrical enclosures rated for the application and location specified:
    1. Outdoor locations.
        a. Type 4, Weatherproof.
    2. Process and corrosive locations.
        a. Type 4X.

D. Disconnect Switch: Provide a lockable, heavy-duty, non-fused, UL listed disconnect switch for mounting near actuator. Where actuated valve is out-of-reach, locate the disconnect switch on an adjacent wall at an accessible level.
    1. Where depicted on the drawings provide auxiliary contact. The contact to close when disconnect switch is in close position. The contact to open when disconnect switch is in open position.

E. Gearing:
    1. Totally enclosed in an oil or grease filled gearcase suitable for operation at any angle.
    2. All drive gearing and components must be of metal construction and machine cut.

3. For rising stem valve (multi-turn), provide hollow output shaft accepting a rising stem and incorporating thrust bearings of the ball or roller type at the base of the actuator. Permit the opening of the gearcase for inspection, and disassembly without releasing the stem thrust or taking the valve out of service.
4. For quarter-turn, self-locking drive gearing to prevent the valve back-driving the actuator.
5. Design all gearing to withstand a 100 percent overload.

F. Torque Switch: Provide electric motor actuators with a double-torque switch set to disengage motor power at 40 to 100 percent of actuator rated torque and less than 75 percent of the shaft's design torque. Operate the torque switch in both the opening and closing directions and operate during the complete cycle without the use of auxiliary relays, linkages, latches, or other devices.
1. Provide each side of the torque switch with a numbered dial for set point adjustment. Mount a calibration tag near each switch for correlating the dial settings with output torque.

G. Position Limit Switch and Relay Contact: Position limit switches or relay contacts adjustable to indicate various positions between the fully opened and fully closed position. Single pole double throw (SPDT) contacts or single pole single throw (SPST) rated at 0.5 amps for 24V DC and 3 amps for 120 V AC. SPST configurable as normally open or normally closed contacts.

H. Hammer Blow Device: Provide electric motor actuators with a built-in lost-motion device that allows sufficient travel of the motor, prior to engaging the stem nut, for the motor to reach full speed. This action to impart a "hammer blow" to start the valve in motion in either direction. Share the load equally by two lugs cast integrally on the drive sleeve.

I. Handwheel: Provide electric motor actuators with a handwheel for manual operation. Do not rotate the handwheel during motor operation. Do not prevent handwheel operation when motor is locked. Accomplish motor or manual selection by a positive declutching knob or lever which disengages the motor and motor gearing mechanically but not electrically. Prohibit manual and motor simultaneous operation. Do not require more than 80 pounds of rim effort at maximum torque for hand operation.

2.04 CONTROL PANEL

A. Provide an operator control unit to serve as a control station for each actuator unless otherwise specified.

B. Control station to include pilot devices:
1. LOCAL (or HAND), OFF, REMOTE (or AUTO), STOP, OPEN, and CLOSE controls through selector switches and/or pushbuttons.
   a. In LOCAL, use the control station's momentary operation of OPEN and CLOSE to position the valve to full open or full close. Configure for inching "maintained or sealed in" action in either travel direction.
   b. In REMOTE:
      1) Open-Close (Isolating) Service:
         a) Contacts Closure: Use momentary operation of external OPEN or CLOSE contacts to open and close the valve.

b) Digital Bus-Network: Use the network communication in lieu of contacts to open and close the valve when specified for remote control.

2) Modulating or Throttling Service:

a) Analog: Use external 4-20 mA input DC isolated signal to position the valve with maximum impedance of 250 ohms.

b) Digital Bus-Network: Use the network communication in lieu of analog to position the valve when specified for remote control.

3) Prevent the controls station's local OPEN and CLOSE devices from operating the valve.

c. In STOP, prevent travel in either open or close direction in both LOCAL and REMOTE.

d. Provide lock in OFF position.

2. Indication:

a. OPEN and CLOSE Status Lights: Color of lights per Division 26

b. Modulating or Throttling Service: In addition to the above status lights, provide digital readout display for the valve position in 1 percent increments from 0 to 100 percent.

c. Digital Bus-Network: N/A

C. Location of Control Station:

1. Local: Control station factory mounted directly to the electric motor actuator.

2. Remote: Control station mounted separate from the electric motor actuator when specified. Provide one of the following options:

a. Add another control station if the factory mounted control station cannot be detached from the electric motor actuator. If two control stations are provided, then both control stations must have identical operations.

b. Remote mount the entire actuator control package compartment including control power transformers, motor contactors and positioners.

D. Remote/External Monitoring:

1. Single pole double throw (SPDT) contacts or single pole single throw (SPST) rated at 0.5 amps for 24V DC and 3 amps for 120 V AC. SPST configurable as normally open or normally closed contacts. Provide dry for contacts for the following when specified:

a. Open Status: Representing valve in full open position.

b. Close Status: Representing valve in full close position.

c. Remote or Auto Status: Representing actuator allows operation from external source.

d. Local or Hand Status: Representing actuator allows operation from the control station.

e. Alarm Status: Representing valve or actuator trouble.

2. Position:

a. Modulating or Throttling Service: In addition to the above remote indication, provide a 4-20 mA DC isolated output signal to indicate valve position at a minimum impedance of 500 ohms.

3. Torque:
    a. Provide torque indication as Digital Bus-Network data for isolating, modulating, and throttling services.

2.05 CONFIGURATION

A. Features:
    1. Non-intrusive or wireless access to view and setup the actuator parameters.
    2. Transfer diagnostic data logged in the actuator memory to a personal computer (PC).
    3. PC graphical user interface software allowing actuator set-up configuration and data logging information to be reviewed, analyzed and reconfigured.

2.06 NAMEPLATES

A. Control Station: Provide nameplates for each control station.
    1. Functional Nameplate: Engrave a black phenolic plate with white lettering with valve functional description and valve equipment number as specified or shown. Permanently fasten functional nameplate to control station. Nameplate wording may be changed without additional cost or time when changes are made prior to commencement of engraving.
    2. Marking Nameplate: Engrave or stamped stainless steel. Permanently fasten nameplate to the control station. Provide the information on nameplate as required by NFPA 70 (NEC) for industrial control panel markings.

B. Motor: Engrave or stamped stainless steel. Permanently fasten nameplate to the motor frame and ensure visibly positioned for inspection. Provide the information on nameplate as required by NFPA 70 (NEC).

C. Actuator: Engrave or stamped stainless steel. Provide the following information on nameplate: manufacturer, model number, serial number, ambient temperature minimum/maximum, rated torque, and opening time.

2.07 ASSEMBLY/FABRICATION

A. Factory-mount electric motor actuators on the valve as a unit. Provide each valve body or actuator with the word "OPEN" cast thereon, an arrow indicating the direction to open, and flow direction arrows.

PART 3 EXECUTION

3.01 PREPARATION

A. Prior to installation of the electric motor actuator assemblies, field measure and check all equipment locations, pipe alignments, and structural installations. Ensure that sufficient space and accessibility is available for electric motor actuators.

3.02 INSTALLATION

A. Equipment Mounting.
   1. Locate actuator with unobstructed access for operation and maintenance.
      a. Do not obstruct walkways.
      b. Do not attach to handrails, process piping, or mechanical equipment.
      c. Do not locate where shock or vibration impairs its operation.
   2. Locate remote control station with unobstructed access for operation and maintenance between 48 inches and 60 inches above the floor or a permanent work platform, and within site of the actuator.
   3. Mount actuators to have their manual operating accessory, where possible, located between 48 inches and 60 inches above the floor or a permanent work platform.

B. Nameplates: Locate nameplates in a clearly visible location on the valves. If necessary, reposition and reattach with stainless steel screws or wire.

C. Electrical Interconnection: Comply with Division 26 for power wiring, control wiring and signal wiring.

3.03 FIELD QUALITY CONTROL

A. Provide a factory-trained manufacturer's representative at the site for the following activities.
   1. Inspect actuator's electrical power, control, signal, communication, and grounding wiring for proper termination.
   2. Configure actuator and include:
      a. Actuator Settings: Limit switch, torque position, travel speed, emergency function, and relay functions.

3.04 SYSTEM START UP

A. General Requirements:
   1. Perform testing in accordance with Section 01 91 00, and this Section. Apply no required test without prior notice to the Construction Manager to witness any test. At least 14 days before the commencement of any testing activity, provide a detailed step-by-step test procedure, complete with forms for the recording of test results. Provide all equipment necessary to perform the required tests.
   2. Test each electric motor actuator for each mode of operation including but not limited to both local and remote- open, close, stop, modulation and network operation, as well as, the travel rates, limit switches, jam and torque settings.
   3. Ensure electric motor actuator control can be re-initiated locally and remotely after power loss recovery.
   4. Provide a factory-trained manufacturer's representative at the site to re-adjust actuator setting under normal operating conditions with the specified design process fluid.

3.05 TRAINING

A. Provide operation and maintenance training for the equipment provided under this Section for the Owner's personnel in accordance with Section 01 79 00 and taught by a factory-trained manufacturer's representative. Certify training on Form 43 05 11-B specified in Section 01 99 90.

B. Include in training sessions preventive maintenance requirements, overhaul and troubleshooting instructions, normal operating practices, actuator parameter configuration set-up, and changing actuator parameter settings.

PART 4 APPENDIX - ACTUSPECS

4.01 ACTUSPECS

A. General requirements for actuators specified in this Section are listed on ACTUSPEC sheets herein.

Table A

ACTUSPEC Symbol	Actuator Description	Actuator Service Power
EMTI-480V	Electric Multi-Turn Actuator for Isolating (Open-Close) Service	480 V AC, 3 phase
EMTM-480V	Electric Multi-Turn Actuator for Modulating Service	480 V AC, 3 phase
EMTT-480V	Electric Multi-Turn Actuator for Throttling Service	480 V AC, 3 phase
EQTI-480V	Electric Quarter-Turn Actuator for Isolating (Open-Close) Service	480 V AC, 3 phase
EQTM-480V	Electric Quarter-Turn Actuator for Modulating Service	480 V AC, 3 phase
EQTT-480V	Electric Quarter-Turn Actuator for Throttling Service	480 V AC, 3 phase
EQTI-120V	Electric Quarter-Turn Actuator for Isolating (Open-Close) Service	120 V AC, 1 phase
EQTI-120V-O or C	Electric Quarter-Turn Actuator for Isolating (Open-Close) Service, Spring Return CW or CCW	120 V AC, 1 phase

4.02 ACTUATOR IDENTIFICATION: EMTI-480V

A. Actuator Description: Electric Multi-Turn Actuator for Isolating (Open-Close) Service.

B. Manufacturers:
   1. Rotork, IQ3 Range.
   2. Auma, SA Range w/ AC Controls
   3. No Substitution

C. Features:
   1. Actuator Type: Electric (E).
   2. Actuator Motion: Multi-turn (MT).
   3. Actuator Service: Isolating (I).
   4. Actuator Power Supply: 480 V AC, 3-phase, 60 Hz.
   5. Fail Position: Last.
   6. Controls:
      a. Voltage: 24 V DC.

b. Voltage Source: External supply.
c. Remote Control Type: Contact Closure.
d. Emergency Shutdown: Fail last state.
e. Location of Control Station: Local unless otherwise specified.

4.03 ACTUATOR IDENTIFICATION: EMTM-480V

A. Actuator Description: Electric Multi-Turn Actuator for Modulating Service.

B. Manufacturers:
1. Rotork, IQ3 Range IQM3.
2. Auma, SAR Range w/ AC Controls
3. No Substitution

C. Features:
1. Actuator Type: Electric (E).
2. Actuator Motion: Multi-turn (MT).
3. Actuator Service: Modulating (M).
4. Actuator Power Supply: 480 V AC, 3-phase, 60 Hz.
5. Fail Position: Last.
6. Controls:
a. Voltage: 24 V DC.
b. Voltage Source: External supply.
c. Remote Control Type: Analog.
d. Emergency Shutdown: A minimum of one independent signal when applied to the actuator overrides any existing command signal and sends valve in a preselected shut down position.
e. Location of Control Station: Local unless otherwise specified.

4.04 ACTUATOR IDENTIFICATION: EMTT-480V

A. Actuator Description: Electric Multi-Turn Actuator for Throttling Service.

B. Manufacturers:
1. Rotork, IQ3 Range IQM3.
2. Auma, SA Range w/ AC Controls
3. No Substitution

C. Features:
1. Actuator Type: Electric (E).
2. Actuator Motion: Multi-turn (MT).
3. Actuator Service: Throttling (T).
4. Actuator Power Supply: 480 V AC, 3-phase, 60 Hz.
5. Fail Position: Last.

6. Controls:
    a. Voltage: 24 V DC.
    b. Voltage Source: External supply.
    c. Remote Control Type: Analog & Discrete
    d. Emergency Shutdown: A minimum of one independent signal when applied to the actuator overrides any existing command signal and sends valve in a preselected shut down position.
    e. Location of Control Station: Local unless otherwise specified.

4.05 ACTUATOR IDENTIFICATION: EQTI-480V

A. Actuator Description: Electric Quarter-Turn Actuator for Isolation Service.

B. Manufacturers:
    1. Rotork, IQT3 or IQ3 Series.
    2. Auma, SA/SQ Range w/ AC Controls
    3. No Substitution

C. Features:
    1. Actuator Type: Electric (E).
    2. Actuator Motion: Quarter-turn (QT).
    3. Actuator Service: Isolating (I).
    4. Power Supply: 480 V AC, 3-phase, 60 Hz.
    5. Fail Position: Last.
    6. Controls:
        a. Voltage: 24 V DC.
        b. Voltage Source: External supply.
        c. Remote Control Type: Contact Closure.
        d. Emergency Shutdown: A minimum of one independent signal when applied to the actuator overrides any existing command signal and sends valve in a preselected shut down position.
        e. Location of Control Station: Local unless otherwise specified.
    7. Gear Train: 90-degree gear box.

4.06 ACTUATOR IDENTIFICATION: EQTM-480V

A. Actuator Description: Electric Quarter-Turn Actuator for Modulating Service.

B. Manufacturers:
    1. Rotork, IQT3 or IQM3Series.
    2. Auma, SAR/SQR Range w/ AC Controls
    3. No Substitution

C. Features:
    1. Actuator Type: Electric (E).
    2. Actuator Motion: Quarter-turn (QT).

3. Actuator Service: Modulating (M).
4. Power Supply: 480 V AC, 3-phase, 60 Hz.
5. Fail Position: Last.
6. Controls:
    a. Voltage: 24 V DC.
    b. Voltage Source: External supply.
    c. Remote Control Type: Analog and Discrete
    d. Emergency Shutdown: A minimum of one independent signal when applied to the actuator overrides any existing command signal and sends valve in a preselected shut down position.
    e. Location of Control Station: Local unless otherwise specified.

4.07 ACTUATOR IDENTIFICATION: EQTT-120V

A. Actuator Description: Electric Quarter-Turn Actuator for Throttling Service.

B. Manufacturers:
1. Rotork, IQT3 or IQM3 Series.
2. Auma, SA/SQ Range w/ AC Controls
3. No Substitution

C. Features:
1. Actuator Type: Electric (E).
2. Actuator Motion: Quarter-turn (QT).
3. Actuator Service: Throttling (T).
4. Power Supply: 120 V AC, 1-phase, 60 Hz.
5. Fail Position: Last.
6. Controls:
    a. Voltage: 24 V DC.
    b. Voltage Source: External supply.
    c. Remote Control Type: Analog and Discrete
    d. Emergency Shutdown: A minimum of one independent signal when applied to the actuator overrides any existing command signal and sends valve in a preselected shut down position.
    e. Location of Control Station: Local unless otherwise specified.

4.08 ACTUATOR IDENTIFICATION: EQTT-480V

A. Actuator Description: Electric Quarter-Turn Actuator for Throttling Service.

B. Manufacturers:
1. Rotork, IQT3 or IQM3 Series.
2. Auma, SA/SQ Range w/ AC Controls
3. No Substitution

C. Features:
   1. Actuator Type: Electric (E).
   2. Actuator Motion: Quarter-turn (QT).
   3. Actuator Service: Throttling (T).
   4. Power Supply: 480 V AC, 3-phase, 60 Hz.
   5. Fail Position: Last.
   6. Controls:
      a. Voltage: 24 V DC.
      b. Voltage Source: External supply.
      c. Remote Control Type: Analog and Discrete
      d. Emergency Shutdown: A minimum of one independent signal when applied to the actuator overrides any existing command signal and sends valve in a preselected shut down position.
      e. Location of Control Station: Local unless otherwise specified.

4.09 ACTUATOR IDENTIFICATION: EQTI-120V

A. Actuator Description: Electric Quarter-Turn Actuator for Isolation Service.

B. Manufacturers:
   1. Rotork Remote Control RCEL.
   2. Flowserve Worchester, Series 75.
   3. GE Remote Control Series (RCS), Model MAR.
   4. Emerson Bettis TorqPlus, Series EM.
   5. Or equal.

C. Features:
   1. Actuator Type: Electric (E).
   2. Actuator Motion: Quarter-turn (QT).
   3. Actuator Service: Isolating (I).
   4. Power Supply: 120 V AC, 1-phase, 60 Hz.
   5. Fail Position: Last.
   6. Applications:
      a. Stall Torque: 150 to 900 lb.-in.
      b. Current at Rated Stall Torque: Less than 2 amps for 25 % duty.
   7. Controls:
      a. Voltage: 120 V AC.
      b. Voltage Source: External fed.
      c. Remote Control Type: Contact Closures.
      d. Location of Control Station: Remote and not specified in this Section.
      e. Manual Override: Required.

8. Indication- Open/Close Position:
    a. Local: Required.
9. Gear Train: Direct attach to actuator with no intermediate gearings or linkage.
    a. Lubrication: Permanently lubricated.

4.10 ACTUATOR IDENTIFICATION: EQTI-120V-O OR C

A. Actuator Description: Electric Quarter-Turn Actuator for Isolation Service, Spring Return or Battery Backup, CW or CCW.

B. Manufacturers:
1. Rotork Remote Control RCEL-S.
2. GE Remote Control Series (RCS), Model SURE.
3. Emerson Bettis TorqPlus, Series EM.
4. Or equal.

C. Features:
1. Actuator Type: Electric (E).
2. Actuator Motion: Quarter-turn (QT).
3. Actuator Service: Isolating (I).
4. Power Supply: 120 V AC, 1-phase, 60 Hz.
5. Fail Position: Open or Close (OC)
6. Applications:
    a. Stall Torque: 300 to 1200 lb.-in.
    b. Current at Rated Stall Torque: Less than 1.5 amps for 50 % duty or better.
7. Controls:
    a. Voltage: 120 V AC.
    b. Voltage Source: External fed.
    c. Remote Control Type: Contact Closures.
    d. Location of Control Station: Remote and not specified in this Section.
    e. Manual Override: Required.
8. Indication- Open/Close Position:
    a. Local: Required.
9. Gear Train: Direct attach to actuator with no intermediate gearings or linkage.
    a. Lubrication: Permanently lubricated.

END OF SECTION

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SECTION 40 05 57.53

PNEUMATIC ACTUATORS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes requirements for pneumatic actuators to produce rotary and linear motion to activate quarter-turn and multi-turn valves and gates in open-close, throttling, and modulating services.

1.02 RELATED SECTIONS:

A. Section 40 05 01 Piping Systems

1.03 REFERENCES

A. This Section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this section prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/AWWA C541-16	Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
ANSI/NEMA 250	Enclosures for Electrical Equipment (1,000 Volts Maximum).
ANSI/NFPA 70	National Electrical Code.
UL 429	Electrically Operated Valves.
UL 1002	Electrically Operated Valves for Use in Hazardous (Classified) Locations.

1.04 DEFINITIONS:

A. Use ANSI/AWWA C541-16, Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates definitions, unless otherwise noted.

B. For purposes of this Section, the word “valve” refers to both valves and gates.

C. Pneumatic actuators are defined using the following code system which appears in the actuator specification (ACTUSPEC) sheets:

Actuator Type			Actuator Features	
Category	Motion	Service	Type	Fail Position
X	X	X	-Act	-Z
• P = Pneumatic	• QT = Quarter-Turn • MT = Multi-Turn	• I = Isolating (Open-Close) • T = Throttling • M = Modulating	• D = diaphragm • P = piston • V = rotary vane • R = Rack & Pinion • S = Scotch Yoke	• Blank = Last • O = Open • C = Closed

D. Service:
1. Modulating: Operation characterized by the continuous positioning of a valve between fully open and closed, in response to a continuous control signal.
2. Open-Close: To move valve to fully open or fully closed position in one continuous operation. Alternative terms used are ON-OFF and isolating.
3. Throttling: Operation characterized by the deliberate and/or the infrequent movement of a valve to an intermediate position, between fully open and fully closed, and maintaining that position for periods of time.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Data: Ensure the valve data is provided to the actuator manufacturer. Transmit valve characteristics:
   a. The size and type of valve driven by actuator.
   b. Rising stem, non-rising stem, or quarter turn.
   c. Valve stem data:
      1) Type of stem (threaded, round with keyway, square, splined, etc.
      2) If threaded, thread type, pitch and lead.
      3) Dimensions of stem and keyway.
      4) Orientation (i.e. clockwise to close or clockwise to open).
      5) Weight of gate and stem for slide gate.
   d. Maximum torque/thrust of the valve.
2. Conditions: Identify most adverse conditions to be encountered at any time when actuation is necessary.
   a. The maximum seating and unseating torque or thrust of the valve, including factor of safety.
   b. The maximum running and dynamic torque or thrust of the valve over the full cycle.
   c. The minimum driver medium pressure at the time of actuation.

3. Coordinate the use of instrument air for the media driver of the pneumatic actuators. Provide each actuator an isolation safety exhaust valve with locking handle at each branch airline to the actuator. Provide air quality as required by the actuator manufacturer.

1.06 SUBMITTALS

A. Procedures: Section 01 33 00.

B. Action Submittals.
   1. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from Section requirements.
   2. A copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this Section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, mark the drawing or drawings with "no changes required".
   3. Manufacturer's catalog information and other data confirming conformance to design and material requirements.
   4. Actuator Data Sheet: An information data sheet for each actuator showing:
      a. Actuator: Manufacturer/model, actuator type (e.g. piston cylinder, rack and pinion, scotch yoke, vane), available maximum/minimum air supply pressure, failure mode on loss of pneumatic pressure (e.g. fail close, fail open, fail in last), actuator torque output at minimum driver medium pressure available.
      b. Control Device:
         1) Open/Close (On/Off) Applications: Solenoid manufacturer/model, solenoid type (2, 3, 4- position), coil voltage.
         2) Throttling or Modulating Applications: Manufacturer/model, positioner type (pneumatic, analog, digital), pressure range, input signal.
      c. Failure Mode on Loss of Control Signal, Loss of Power, Loss of Air: Fail close, fail open, fail in last.
      d. Position Switches: Manufacturer/model, type, quantity, voltage.
      e. Position Feedback: Manufacturer/model, output signal, fieldbus protocol.
      f. Manual Override: Handwheel location, maximum rim force on handwheel.
      g. Operating Cycle Time Requirements: Time for valve to travel from full closed to full open and vice-a-versa.
      h. Application Considerations: Minimum/maximum operating temperature, NEMA rating for electrical enclosures, air filter size, heater power.
      i. Provide actuator identification (tag) number clearly for each application on the actuator data sheet.
   5. List of components being provided for each actuator.
   6. Shop drawings:
      a. Actuator assembly.
      b. Dimensions.
      c. Electrical wiring and pneumatic connection diagrams.

7. Actuator sizing report correlating to the coupled valve or gate type, operating torque and specified safety factor [As Applicable]
8. Testing procedures and forms specified in paragraph 3.04 General Requirements.

C. Informational Submittals:
   1. Application software and software manuals for configuring and set up of actuator for control, monitoring and alarming.
   2. Recommended storage practice. In addition, place this information on the outside of the actuator or shipping container as delivered to the site.

D. Closeout Submittals:
   1. Operation and Maintenance Data:
      a. Submit manufacturer's standard operating and maintenance instructions as specified in Section 01 78 23.
      b. Include final reviewed submittal.
      c. Actuator Configuration Settings: The final settings used for configuration of the actuator to meet field operation requirements. Include both the electronic files and a hard copy printout in pdf format.
   2. Training Certification Section 43 05 11-Form B.
   3. Maintenance Material:
      a. Instructions.
      b. Parts list.
      c. Spare Parts.
      d. Special Tools.
      e. Lubrication guide.
      f. Certified drawings.
   4. Testing forms filled in and completed by Contractor.

1.07 QUALITY ASSURANCE

A. Identification of Listed Products:
   1. Provide electronic equipment listed and labeled for the purpose for which they are to be used, by an independent testing laboratory. Three such organizations are Underwriters Laboratories (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). Provide independent testing laboratory acceptable to the inspection authority having jurisdiction.

1.08 DELIVERY, STORAGE AND HANDLING

A. Procedures: Section 01 66 00.

1.09 WARRANTY

A. Manufacturer to warrant all actuators furnished under this Section against defects in materials and workmanship for a period of two years.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Candidate manufacturers are specified on the actuator specification (ACTUSPEC) sheets and the following requirements.

B. The manufacturer's standard models or products may require modification to conform to the specified requirements.

2.02 PERFORMANCE

A. Size actuators to produce an operating torque equal to twice the maximum required valve operating torque under the specified flow and pressure conditions. Specific requirements for each type of actuator are specified on the actuator specification (ACTUSPEC) sheets located at the end of this Section.

B. Ambient Temperature Range: -20 to +160 degree Fahrenheit (up to 100% relative humidity).

C. Travel Speed: Set by Membrane Manufacturer at commissioning to prevent water hammer.

D. Rotation:
   1. Quarter-Turn: 90 degrees, with +/- 5 degree adjustable mechanical travel stops. Stops designed to withstand maximum actuator torque.
   2. Multi-Turn: Position setting range of 2.5 to 8,000 turns with a minimum angular resolution of 7.5 degrees at the output.

2.03 CONFIGURATION, COMPONENTS AND FEATURES

A. General: Unless otherwise specified, provide pneumatic actuators in accordance with the actuator specification (ACTUSPEC) sheets and the following requirements.

B. Actuators
   1. General:
      a. Actuators shall be sized for a range within the minimum of 70 PSIG and maximum of 150 PSIG air media driver pressures, unless otherwise specified.
      b. Stop-Limiting Devices: Equip valve actuator with adjustable mechanical stop-limiting devices to prevent over-travel of the valve in the open and closed positions.
      c. Actuator Action:
         1) Spring return for actuators specified as fail-open or fail-close.
         2) Double acting for actuators specified as fail-last.
   2. Linear Actuators: For use with multi-turn valves.
      a. Linear actuators shall be valve manufacturer's standard diaphragm or piston type.
   3. Rotary Valve Actuators: For use with quarter-turn valves.
      a. Vane actuator

1) Features:
    a) True rotary action.
    b) Compact size.
    c) Use for open/close, modulating and throttling service.
    d) Spring-Return: Reversible fail direction.

b. Rack and pinion actuator:
    1) Features:
        a) Transfer linear motion to rotary motion.
        b) Compact size.
        c) Use for open/close, modulating, and throttling service.
        d) Totally enclosed, with no external moving parts, except for the output shaft which shall be accessible for manual operation of the valve.

c. Scotch yoke actuator:
    1) Features:
        a) Transfer linear motion to rotary motion.
        b) Use for open/close, modulating, and throttling service.
        c) Totally enclosed, with no external moving parts, except for the output shaft which shall be accessible for manual operation of the valve.

C. Manual Gear Override: Provide a declutchable manual gear override handwheel.
    1. Totally enclose gear mechanism and provide an external mechanism allowing the gear to be engaged and disengaged. When manual gear override is disengaged, do not affect the performance of the pneumatic actuator. Do not rotate the handwheel of the manual gear override during operation of the pneumatic actuator.
    2. Provide provisions to exhaust the pressure medium (air) from the pneumatic actuator before operating manually.
    3. Design manual gear override to produce the required operating torque, plus safety factor with a maximum rim pull of 80 lb (356 N) on the rim of the handwheel.

2.04 AIR SUPPLY APPURTENANCES

A. Air Supply and Signal Piping, Fittings and Valves: Provide in accordance with Section Section 40 05 02.05 for instrument air. Size pipes or tubing, fittings and valves per actuator and control devices port size requirements.

B. Air Sets: Provide a filter regulator for each actuator.
    1. Features:
        a. Aluminum body with an output gage connection.
        b. Output pressure gage and range spring appropriate for the intended application.
        c. Output pressure gage a minimum of 2 inches in diameter and an accuracy of plus or minus 2 percent of scale, or better.
        d. The filter element being 10 micron, replaceable and made of resin-impregnated cellulose. The filter drip well equipped with a drain cock.
        e. Filter regulator adjustable over the spring range by means of a wrench-adjustable set screw. The set screw equipped with a lock nut.

f. Filter regulator equipped with an internal relief valve to maintain the output pressure at set point during periods of no flow.

2. Manufacturer:
   a. Emerson, Fisher 67C Series.
   b. Or equal.

2.05 CONTROL DEVICES AND ANCILLARIES

A. Enclosure NEMA 250 rating for all electronic devices must be suitable for the installation area:
   1. Outdoors: NEMA 4.
   2. Corrosive and process: NEMA 4X.

B. Positioners: Required for throttling and modulating service.
   1. Manufacturer: The same manufacturer as the actuator or a partner manufacturer supplied by the actuator manufacturer.
   2. Positioner: Control valve in all positions from fully open to fully closed, and from fully closed to fully open with control in any intermediate position corresponding to the signal input.
      a. Positioner Signal Input:
         1) Analog (Electro-Pneumatic Positioner) : Use an external 4-20 mA DC isolated input signal with a maximum impedance of 250 ohms to position the valve between 0% (full close) and 100% (full open).
         2) Digital Bus-Network (Digital or Smart Positioner): Use the network communication in lieu of analog to position the valve when specified.
      b. Provide the following controls:
         1) Auto/Manual Switch: Allow for local actuator control without removing the positioner cover.
         2) Zero and span adjustment located on the positioner housing.
         3) Change from direct acting to reverse acting in the field without need for special tools.
      c. Accuracy:
         1) Linearity: +/- 2% Full Scale.
         2) Hysteresis: +/- 0.7% Full Scale.
         3) Sensitivity: +/- 0.7% Full Scale.
         4) Repeatability: +/- 0.7% Full Scale.
   3. Position Indication: Visual indication of valve position 0 – 100%.
   4. Position Transmitter Signal Output:
      a. Analog: Provide feedback of the valve position independent of the input signal as a 4-20 mA DC isolated output signal representing 0 – 100%.
      b. Digital Bus-Network: Use the network communication in lieu of analog to provide feedback of the valve position when specified.
   5. Exhaust air mufflers.
   6. Air Supply Monitoring: Provide a pressure gauge on each pneumatic connection.
   7. Air Restrictors: Provide so as to adjust valve open and close travel times.

C. Control Devices: Required for open - close service.
   1. Manufacturer: The same manufacturer as the actuator or a partner manufacturer supplied by the actuator manufacturer.
   2. Solenoid Valve:
      a. Control Signal Input:
         1) Discrete: Use a 120 VAC or 24 VDC input signal to open or close the valve.
         2) Digital Bus-Network: Use the network communication in lieu of discrete to position the valve when specified. Use the requirements of digital or smart positioner for control if solenoid valve can not be controlled via a digital bus-networked directly.
      b. Coil Rating: Class H.
      c. Number of ports to be provided as required for specified actuator action.
      d. Manual override to lock-and-hold valve in either the open or close position in the event of a power outage.
      e. UL listed.
   3. Limit Switches: Position feedback for valve fully open and fully closed positions.
      a. Control Signal Output:
         1) Discrete: Single pole double throw (SPDT) contacts or single pole single throw (SPST) rated at 0.5 amps for 24V DC and 1 amp for 120 VAC.
         2) Digital Bus-Network: Use the network communication in lieu of discrete for indications of fully open and fully closed valve positions when specified.
   4. Position Indication: Visual indication of valve position.
      a. 3D dome style with green = open and red = close.
   5. Air Supply Monitoring: Provide a pressure gauge on each pneumatic connection.
   6. Air Restrictors: Provide so as to adjust valve open and close travel times.

D. Location: Provide mounting hardware for control devices and ancillaries based on location specified in Section 40 06 20.13.
   1. Local: Mounted directly to the actuator.
   2. Remote:
      a. Mounted within 10 feet of the actuator for better user accessibility than local location.
      b. Mounted a distance from the actuator to place electronic devices outside of a classified area.

2.06 NAMEPLATES

A. Actuator: Engrave or stamped stainless steel. Provide the following information on nameplate: equipment number, manufacturer, model number, serial number, supply pressure, maximum supply pressure rating, and actuator size.

B. Identification Tags: Each actuator shall be provided with a 16-gage stainless steel identification tag that bear the equipment description and tag number of the actuator, as specified. Characters shall be 1/4 inch, die-stamped. Identification tags shall be securely attached to the actuator in a readily visible location using stainless steel screws or wire.

2.07 ASSEMBLY/FABRICATION

A. Factory-mount pneumatic actuators on the valve as a unit. Provide each valve body or actuator with the word "OPEN" cast thereon, an arrow indicating the direction to open, and flow direction arrows.

PART 3 EXECUTION

3.01 PREPARATION

A. Prior to installation of the pneumatic actuator assemblies, field measure and check all equipment locations, pipe alignments, and structural installations. Ensure that sufficient space and accessibility is available for pneumatic actuators.

3.02 INSTALLATION

A. Equipment Mounting.
   1. Locate actuator with unobstructed access for operation and maintenance.
      a. Do not obstruct walkways.
      b. Do not attach to handrails, process piping, or mechanical equipment.
      c. Do not locate where shock or vibration impairs its operation.
   2. Locate control devices with unobstructed access for operation and maintenance between 48 inches and 60 inches above the floor or a permanent work platform, and within site of the actuator.

B. Nameplates: Locate nameplates in a clearly visible location on the actuator. If necessary, reposition and reattach with stainless steel screws or wire.

C. Electrical Interconnection: Comply with Division 26 and the actuator manufacturer's requirements.

D. Pneumatic Interconnection: Comply with Section 40 05 01 and the actuator manufacturer's requirements.

3.03 FIELD QUALITY CONTROL

A. Provide a factory-trained manufacturer's representative at the site for the following activities:
   1. Inspection of actuator's air supply, pneumatic piping, valves, fittings, and bracing.
   2. Inspection of control devices and ancillaries, voltages, signal types, power needed, and programming to provide a proper functioning system.
   3. Configuration of actuator, including:
      a. Actuator Settings: Limit switch, stop-limits, travel speed, fail-safe operation, zero, and span.

B. Provide minimum one man-day of on-site valve setup and testing per valve. Insure that air supply, electrical control means, and process fluids are ready for actual valve testing under actual or simulated operating conditions. Set stroke of valve from fully closed to

fully opened position for the control signal range, under actual operating pressure conditions. Set any limit switches provided.

3.04 SYSTEM START UP

A. General Requirements:
   1. Perform testing in accordance with Section 01 45 20, and this Section. Apply no required test without prior notice to the Construction Manager to witness any test. At least 14 days before the commencement of any testing activity, provide a detailed step-by-step test procedure, complete with forms for the recording of test results. Provide all equipment necessary to perform the required tests.
   2. Pneumatic Piping Systems: Test pneumatic piping systems for leaks in compliance with Section 40 05 01.
   3. Test each pneumatic actuator for each mode of operation including but not limited to both local and remote- open, close, stop, modulation and network operation, as well as, the travel rates, and stop/ limit switches.
   4. Ensure pneumatic actuator control can be re-initiated locally and remotely after power and signal loss recovery and pneumatic loss recovery.
   5. Provide a factory-trained manufacturer's representative at the site to re-adjust actuator setting under normal operating conditions with the specified design process fluid.

3.05 TRAINING

A. Provide operation and maintenance training for the equipment provided under this Section for the Owner's personnel in accordance with Section 01 79 00 and taught by a factory-trained manufacturer's representative. Certify training on Form 43 05 11-B specified in Section 01 99 90.

B. Include in training sessions preventive maintenance requirements, overhaul and troubleshooting instructions, normal operating practices, actuator parameter configuration set-up and changing actuator parameter settings (if applciable).

PART 4 APPENDIX - ACTUSPECS

4.01 ACTUSPECS

A. General requirements for actuators specified in this Section are listed on ACTUSPEC sheets herein.

ACTUSPEC Symbol	Actuator Description
PQTI-R	Pneumatic Quarter-Turn Rack And Pinion Actuator For Isolating Service
PQTT-R	Pneumatic Quarter-Turn Rack And Pinion Actuator For Throttling Service
PQTM-R	Pneumatic Quarter-Turn Rack And Pinion Actuator For Modulating Service

4.02 ACTUATOR IDENTIFICATION: PQTI-R/PQTT-R/PQTM-R

A. Actuator Description: Pneumatic quarter-turn rack and pinion actuator for isolating (Open-Close), throttling or modulating service.

B. Manufacturers:
   1. Rotork, GT.
   2. Flowserve, Valtek.
   3. Flowserve, Worchester F39.
   4. Bray, Series 92/93.
   5. Or equal.

C. Features:
   1. Actuator Category: Pneumatic (P).
   2. Actuator Motion: Quarter-turn (QT).
   3. Actuator Service: Isolating (I), throttling (T) or modulating (M).
   4. Actuator Type: Rack and Pinion (R).
   5. Actuator Power Supply: As specified for minimum and maximum air pressures.
   6. Fail Position upon Power Loss: Last, Open or Close as specified.
   7. Fail Position upon Air Loss: Same fail position upon Power Loss, unless otherwise specified.
   8. Controls and Ancillaries: Requirements based on service as specified.
   9. Actuator Materials:
      a. Housing: Aluminum alloy or stainless steel.
      b. Head and Cap: Same material as housing.
      c. Rack: Metal of dual construction or single rack design with suitable low friction slide bearings.
      d. Output Shaft/Pinion: Aluminum, electroless nickel plated steel, stainless steel, or other corrosion-resistant metal.
      e. Pinion Gears and Bearings: Pinion gears metal and positively engaged with rack. Bearings corrosion resistant material
      f. Shaft and Rack (Piston) Seals: O-ring or mechanical seals of a material compatible with hydrocarbon-based lubricate.
      g. Spring return: Stainless spring steel or chrome silicon (corrosion resistant coated).
      h. Fastener/Hardware: Stainless steel.
   10. Lubrication: Bearing surfaces, including the inside cylinder wall and guides, shall be coated with a permanent, dry-film lubricant and corrosion inhibitor.

END OF SECTION

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SECTION 40 05 59.23

FABRICATED SLIDE GATES

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies the minimum requirements for corrosion-resistant fabricated slide gates (gates) for control of water flow as shown on the Drawings and specified herein. Gates shall be all 316L stainless steel construction. The scope of supply shall include gate frames, slides, seals, stems, stem guides, operators, floor stands, gate enclosures where specified, and all other appurtenances, in-place and complete. Powered operators for gates are specified in Section 40 06 20.13.

B. EQUIPMENT LIST: Equipment provided under this section is listed in paragraph 1.04, Service Requirements.

1.02 QUALITY ASSURANCE

A. REFERENCED STANDARDS: This Section incorporates by reference the latest revisions of the following documents. In case of conflict between the requirements of this Section and the listed documents, the requirements of the Contract Specifications shall prevail.

Reference	Title
ASTM A240	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A276	Standard Specification for Stainless Steel Bars and Shapes
ASTM D2000	Standard Classification System for Rubber Products in Automotive Applications
AWWA C561-12	Fabricated Stainless Steel Slide Gates
ASTM A380	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems

B. UNIT RESPONSIBILITY: Unit responsibility, as specified in Section 43 05 11, is assigned to the gate manufacturer (Manufacturer) for the gates and appurtenances specified in this Section and for the powered operators specified in Section 40 06 20.13.

C. All gates for this project shall be supplied by the same Manufacturer, who shall be fully experienced, reputable and qualified in the manufacturing of the equipment furnished and who has been fabricating gates and appurtenances for a minimum period of 10 years.

1.03 SUBMITTALS

A. PROCEDURES: Section 01 33 00.

B. Product information, calculations, charts and graphs demonstrating compliance with the requirements of this Section and the Drawings.

C. Plans, elevations, sections, and details showing dimensions and mounting requirements for each gate specified.

D. Manufacturer's data including materials of construction, construction details of equipment, and weight of equipment.

E. Manufacturer's product literature.

F. Electric motor operator data, where applicable, including manufacturer's catalog information, complete dimensional data, drive unit size, calculations substantiating selection and wiring diagrams.

G. Certificate of unit responsibility attesting that unit responsibility has been assigned as specified in this Section and Section 11000. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.

H. Results of factory testing including leak testing per AWWA C-561, Section 5.22.

I. Name, location and qualifications of the passivation shop.

J. Certification attesting that all gate components have been cleaned, passivated and tested in accordance with the procedures described in this section

K. Manufacturer's operation and maintenance manual defining maintenance requirements.

1.04 SERVICE REQUIREMENTS

A. PERFORMANCE REQUIREMENTS
   1. Gates are intended to isolate channels and pipes or to control water surface elevations.
   2. Gates shall be designed for the Design Head specified. The Design Head is defined as the maximum head that will be applied to the gate. The Design Head is measured from the maximum water surface elevation to the bottom of the gate.
   3. Slides and frames shall have a safety factor of 5 with regard to ultimate tensile, compressive and shear strength; calculations shall be submitted to show conformance.
   4. Gates shall comply with field leakage tests as defined in AWWA C561.
   5. Gates shall not require exercise at a frequency of more than once per year to meet the extended warranty requirements described in this section.
   6. Gates shall be passivated prior to shipping in accordance with the requirements of this section.

B. See the Gate Schedule for specific dimensional and design requirements.

Gate Schedule

Equipment Number	Gate Type [a]	Size W X H [b] (inches)	Frame Type [c]	Frame Mounting [d]	Design Head [e], feet		Operator Type [f]	Operator Mount [g]	Special Feature [h]
					Seating	Unseating			
SG4010	W	36 x 24	NSC	5	0	6	MH	SP	EN
SG4020	W	36 x 24	NSC	5	0	6	MH	SP	EN
SG4030	W	36 x 24	NSC	5	0	6	MH	SP	EN

a. C = channel, S = Sluice, W = weir

b. Nominal size of opening (aperture style gates) or channel width x slide height (channel and weir gates). See Drawings for additional dimensional requirements.

c. SC = self contained, NSC = non self contained

d. 1 = embedded frame/sill, 2 = wall mounted with embedded sill, 3 = upper section of frame wall mounted with sill and lower portion of frame embedded (e.g., sluice style gate mounted in channelized structure), 4 = flange mounted, 5 = wall mounted (weir type)

e. Design Head is the maximum water surface elevation minus the invert elevation of the gate.

f. MH = manual hand wheel, MFN = manual 2" floor nut, E = electric motor

g. YTT = yoke-mounted torque tube, SP = structure-mounted pedestal, YA = yoke-mounted actuator, WB = wall bracket

h. RB = radius bottom, DS = dual stem, EN = stainless steel enclosure.

1.05 COMPONENT SIZING

A. Operating forces used for determining the strength of gate components (yokes, frames, slides, stems, slide nut pockets, and other load-bearing members) shall be based on the sum of the guide friction force (computed using an opening breakaway friction factor of 0.2) and the weight of slide and stem.

B. When the gate is in motion, the operating forces shall be based on the sum of the frictional force (using a guide friction factor of 0.25) and the weight of slide and stem.

1.06 STAINLESS STEEL CLEANING REQUIREMENTS

A. All Stainless Steel components shall be protected, cleaned and tested as follows:
   1. Stainless steel components shall be protected from carbon steel contamination during fabrication and assembly as defined in Paragraph 8 of ASTM A380. Surfaces surrounding joints shall be cleaned as discussed in Paragraph 6.3 prior to welding. Careful adherence to good stainless steel practices may minimize descaling and cleaning requirements.
   2. Welding temperatures shall be carefully monitored as to not sensitize the material and thereby increase the risk of intergranular corrosion.
   3. After completion of welding, all surfaces shall be descaled as necessary using methods described in Paragraph 5 of ASTM A380. Weld surfaces (including surfaces within the heat affected zone of the weld) shall be descaled using a pickling solution as discussed in Paragraph 5.2. Surfaces shall be thoroughly rinsed in accordance with Paragraph 5.2.5.
   4. Following descaling, all surfaces shall be cleaned as necessary using methods described in Paragraph 6 of ASTM A380. Final cleaning of all surfaces shall be in accordance with Paragraph 6.4.

5. Upon completion of cleaning, all surfaces shall be visually inspected in accordance with Paragraph 7.2.1 of ASTM A380 prior to testing. Any gross indications of iron as defined in Paragraph 7.2.1.1 shall be cleaned as necessary.
6. Testing to ensure proper passivation and cleaning has occurred shall be as defined in Paragraph 7.2.5 of ASTM A380. First, perform a water-wetting and drying test on all stainless-steel surfaces in accordance with Paragraph 7.2.5.1 of ASTM A380 or a Practice A - Water immersion Test as defined in Paragraph 14.1 of ASTM A967. Failed areas shall be re-cleaned and retested using a Copper Sulfate Test in accordance with Paragraph 7.2.5.3 or Practice D - Copper Sulfate Test found in Paragraph 14.4 of ASTM A967. Any remaining failed areas shall be cleaned using a nitric acid solution in accordance with Table A2.1 Part II of ASTM A380 followed by retesting of all affected areas using a Copper Sulfate Test.
7. Manufacturer shall notify Engineer of any failed tests. No equipment shall be shipped without certification that all surfaces have passed inspection and testing. Manufacturer shall remove test chemical in accordance with the testing manufacturers recommendations. No visible indications of iron may exist prior to shipment.
8. Any evidence of rust or blooming upon arrival on site shall be the responsibility of the manufacturer to address and repair at their own expense.
9. Any indications of corrosion occurring on the equipment during the warranty period shall be investigated to determine cause of contamination. Should the manufacturer be found responsible for the corrosion due to improper cleaning of the equipment or improper welding practices, the manufacturer be responsible to address and repair the equipment as necessary at their own expense.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Gates shall be all stainless steel construction. Acceptable manufacturers include the following:
   1. Stainless steel slide gate manufacturers:
      a. Whipps, Inc. Athol, Massachusetts
      b. Waterman Industries, Exeter California
      c. Or approved Equal

B. The manufacturer's standard models or products may require modifications to conform to specified requirements.

2.02 MATERIALS

A. Materials of construction shall be as follows:

Component	Material
Slide	ASTM A240 Type 316L stainless steel
Frame	ASTM A276 Type 316L stainless steel
Slide Seats	ASTM D4020 UHMW Polyethylene
Seating faces or seals	ASTM D4020 UHMW PE

Stem and supports	ASTM A276 Type 316 stainless steel
Fasteners, adjusting hardware, and anchors	ASTM A276 Type 316 stainless steel
Yoke	ASTM A276 Type 316L stainless steel
Flush bottom seal	Resilient synthetic rubber bonded to frame or ASTM D2000 neoprene
Pedestal/Torque Tube	ASTM A276 Type 316L stainless steel
Enclosure	ASTM A276 Type 316L stainless steel

2.03 FEATURES

A. GENERAL:

1. Mounting requirements as shown on the Drawings and specified in this section.
2. Unless otherwise indicated, provide gates with rising stems with clear, graduated plastic covers in accordance with AWWA C561.
3. Weir gates having a width greater than 60 inches shall have dual stems mechanically linked to a common operator.
4. Stainless Steel Passivation: All stainless steel components to be cleaned, descaled, and passivated after fabrication in accordance with ASTM A380 and the specific requirements of this section.

B. SLIDE:

1. Slides shall consist of steel plate reinforced with steel members welded to the plate. Minimum thickness of the steel plate shall be ¼".
2. Slides shall be reinforced with horizontal stiffeners welded to vertical stiffeners. Slides shall not deflect more than 1/1000 of the span of the gate under the design head.
3. Gates with an opening width x design head of 80' or greater shall incorporate a 3" minimum structural edge extended into the guide grove or design equivalent.
4. The slide manufacturer shall submit drawings and comprehensive design criteria to substantiate that the maximum deflection for each slide has not exceeded 1/1000 of the span regardless of the type used. Comprehensive safety factor calculations shall include bending moments, buckling stress, and bonding stress with thermal expansion factors. Safety factors shall be calculated for the slide under the maximum head indicated in this section, and for shear at the slide/seal interface.

C. FRAME:

1. Guide frames extending above operating floors or slabs shall be self-contained and sufficiently strong so that no further support or reinforcement is required. Frames for self-contained gates shall be designed for maximum loads imposed by gate operators in the stalled condition plus the weight of the slide, stem, torque tube or pedestal, and operator.
2. The yoke shall be formed by two structural members welded at the top of the guides to provide a one-piece rigid frame and configured to enable slide removal without removing the yoke. The yoke shall be designed to support the maximum stall force applied by the operator in addition to the weight of the stem, torque tube or pedestal, and operator where this equipment is being supported at the yoke.

3. The frame shall be designed with a minimum factor of safety of 4 with regard to ultimate tensile, compressive, and shear strength.
4. Wall-mounted frames shall be the flanged type. Guides for wall mounted frames shall be formed from one plate with wrap around gussets. Bolted together guides are not accepted.
5. Embedded frame gates shall be installed in block-out recesses formed in the channel walls and floor.
6. Thimble-mounted gates shall be drilled to match the wall thimble. Wall thimbles shall conform to AWWA C561.

D. SEALS:
1. Gates shall incorporate factory-set self-adjusting seals utilizing a sealing surface of UHMW PE to achieve the leakage rates specified. Self-adjusting seals shall not require adjustment and shall be replaceable without removing the guide frame.
2. All moving contact surfaces shall be incompatible to each other thereby minimizing sticking or jamming.

E. STEMS:
1. All stems shall be of the rising type unless otherwise specified.
2. Provide stem diameter to withstand at least twice the rated output of the electric operator or the manual operator at 40-pounds pull. Stems shall be minimum 1-3/8-inch diameter.
3. Stem guides shall be provided at intervals necessary to maintain a slenderness ratio (L/R) of the unsupported stem length of less than 200, where R is the radius of gyration of the stem.
4. Stems shall be designed to withstand tensile and compressive loads that occur under maximum operating conditions. Design for compressive loading shall meet AISC code where K=1 with a minimum safety Factor of 2 to 1.
5. Stem sections shall be joined together by solid couplings, threaded and keyed to the stems. All couplings of the same size shall be interchangeable.
6. The threaded portion of the stem shall have dual lead, machine rolled, full depth ACME type threading with a 16 micro-inch finish or better. Stub threads are not acceptable.
7. Stems shall be fixed to the slide by a threaded and keyed assembly into a lifting nut attached to the disc in a lifting bracket, which is bolted to the disc. The bolts securing the bracket shall be in tension and not shear.
8. Yoke-supported stems shall be provided with a torque between the top of the yoke and the operator constructed of 316L SS. The torque tube shall have appropriate flanges at the top and bottom for mounting to the operator and yoke, and be sized and constructed to provide lateral support to the stem between the yoke and the operator. Torque tubes shall be provided with UHMW stem guides at appropriate intervals to provide lateral support to the stem. Torque tubes shall be equipped with tabs for bolting lateral supports; the dimensions and location of the tabs shall be determined by the manufacturer and coordinated during the submittal review process.

F. OPERATORS:
   1. See Gate Schedule for operator requirements.
   2. Unless otherwise indicated, manual operators shall meet requirements of AWWA C561 as appropriate.
   3. Yoke-supported operators shall be provided with 316 SS pedestals between the top of the yoke and the operator. See drawings for length requirements.
   4. Unless otherwise indicated and whenever possible, operator base shall be set 42" above the walking surface.
   5. Manual operators are specified in Section 40 05 57.13.
   6. Electric operators are specified in Section 40 05 57.23.

G. ENCLOSURES:
   1. Gates isolating pipes and channels within the headworks structure shall be equipped with all stainless steel enclosures for odor control purposes.
   2. Enclosures shall be designed and fabricated by the gate manufacturer. Submit drawings prior to fabrication.
   3. Enclosures shall be essentially air tight and designed to withstand negative pressure of 0.3" WC imposed by the odor control system drawing air from below the channel covers.
   4. Enclosures shall be compatible with specified electric actuators and shall be removable without removing the actuator.

H. Enclosure face panels shall be removable from one side. Removable panels shall be provided in sections weighing no more than 30-pounds each. Provide handles for lifting the removable face panels.

I. APPURTENANCES:
   1. Frame welded flushing connections shall be provided at inverts of gate frames with flushing ports for 100 psig compressed air or 1000 psi high pressure water. Flushing connections shall be provided for gates 48-inches in height or taller. Tubing shall be a minimum of 1/4-inch diameter, Type 316L Stainless Steel. Tubing shall be integral with the frame and secured via permanently frame welded guides to prevent dislodgement. Both sides of the frame invert shall be provided with flushing connection. Penetration into the gate frame shall not interfere with gate operation. Penetration shall be performed at the manufacturer's facility. Tubing on both sides of the frame shall terminate to a 1/2-inch diameter Type 316 stainless steel quick disconnect fitting, Snap-Tite/Parker series 71 or approved substitute. Fitting shall terminate just below floor invert. Manufacturer and Contractor shall coordinate location of quick disconnect valve box to avoid conflict with other valve boxes, equipment, etc.

2.04 FACTORY TESTING

A. Conduct shop performance test per AWWA C563 or AWWA C561 as applicable. Gates SG4010, SG4020, SG4030 shall be factory leak tested and field leak tested following installation. Submit written report of results.

B. The Owner retains the right to witness the stainless steel preparation and passivation process. Provide at least 30-days notice prior to start of passivation process for gates and appurtenances.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install gates and appurtenances in accordance with manufacturer's instruction and as shown on the Drawings.

B. For embedded gates, fill blockouts along guide frames and gate sill with grout following installation.

C. Provide all 316 SS anchors; size anchors in accordance with the design requirements specified in this section and in accordance with Sections 01 73 24, 05 10 00, and 43 05 11.

D. Proper handling shall incorporate all practices described in Section 8.5 – Protection of Cleaned Surfaces, ASTM A380. Passivated parts contaminated due to improper handling and installation will require retesting for the presence of free iron and re-passivation if free iron is detected.

3.02 FIELD TESTING

A. Operation and Leakage Tests: In accordance with AWWA C563 or AWWA C 561 as appropriate.

B. Leakage rates shall not exceed 0.05 gpm per linear foot of seating perimeter.

3.03 TRAINING

A. Provide four hours of training as specified in Section 01 66 00. Training shall be certified on Form 43 05 11-B specified in Section 01 73 24.

END OF SECTION

SECTION 40 05 60

VALVES

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies the supply, installation and testing of valves. Materials and performance requirements for valves are specified in Detailed Valve Specifications. Detailed Valve Specifications are provided in Sections 40 05 61.01 through 40 05 89.99. Additional Detailed Valve Specifications for some valves used for HVAC service are provided in Division 23.

B. Determining Valve Type:
   1. Drawings specify valve types (gate, plug, butterfly, check, globe, etc.) used in each pipeline. Process fluids that will be conveyed in pipelines are identified by the Process Service Identifiers shown on the Drawings.
   2. Piping System Schedules (Sections 40 05 02.01 through 40 05 02.99) specify piping system materials and components, including valve requirements, based on the Process Service Identifier specified on the Drawings for the pipeline or piping system. Piping System Schedules reference Detailed Valve Specifications that specify requirements for each valve type used in the pipeline or piping system.
   3. Provide valves conforming to the Detailed Valve Specifications listed in the Piping System Schedule for the valve/line size, process service, and valve type specified on the Drawings.

      Example: *The Drawings specify a ball valve on a 1-inch line. The Piping System Schedule for the process service specified on the Drawings refers to Section 40 05 63.01 for 1/2 through 2 1/2 inch ball valves. For this example, provide the subject ball valve per the requirements specified in 40 05 63.01.*

C. Section 40 06 20.13 specifies electric, pneumatic, and hydraulic powered control valves, complete with valve, actuator, and other ancillaries.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 58 01 – Identification Systems
   2. Section 01 78 23 – Operation and Maintenance Manual
   3. Section 40 05 02 – Detailed Piping Specification Sheets
   4. Section 40 06 20.13 – Actuated Valve and Gate Schedules

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI 16.10	Face-to-Face and End-to-End Dimensions of Valves
ANSI B1.20.1	Pipe Threads, General Purpose
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, and 250
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B16.34	Valves—Flanged, Threaded, and Welding End
API 607	Fire Test for Quarter-turn Valves and Valves Equipped with Nonmetallic Seats
ASTM A48	Gray Iron Castings
ASTM A108	Steel Bars, Carbon, Cold-Finished, Standard Quality
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A216/A216M	Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
ASTM A276	Stainless and Heat Resisting Steel Bars and Shapes
ASTM A351	Castings, Austenitic, for Pressure-Containing Parts
ASTM A516	Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A536	Ductile Iron Castings
ASTM A571	Austenitic Ductile Iron Castings
ASTM A995/A995M-13	Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts
ASTM B124	Copper and Copper Alloy Forging Rod, Bar, and Shapes
ASTM B148	Aluminum-Bronze Sand Castings
ASTM C283	Resistance of Porcelain Enameled Utensils to Boiling Acid
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D5162	Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates
AWWA C500	Metal-Seated Gate Valves for Water Supply Service
AWWA C504	Rubber-Seated Butterfly Valves
AWWA C507	Standard for Ball Valves
AWWA C508	Swing Check Valves for Waterworks Service, 2 – 24 Inches NPS
AWWA C517	Resilient-Seated Cast Iron Eccentric Plug Valves
AWWA C550	Protective Interior Coatings for Valves and Hydrants
MSS SP-70	Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-80	Bronze Gate, Globe, Angle and Check Valves
MSS SP-81	Stainless Steel, Bonnetless, Flanged, Knife Gate Valves
MSS SP-110	Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
NSF 61	Drinking Water System Components - Health Effects
UL 429	Electrically Operated Valves
UL 1002	Electrically Operated Valves for Use in Hazardous Locations, Class I, Groups A, B, C, and D, and Class II, Groups E, F, and G

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00
   2. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from specification requirements. Check-marks (✓) denote full compliance with a paragraph as a whole. Underline deviations and denote with a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal will be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Catalog cuts and/or shop drawings for each type of valve indicating the valve type (Detailed Valve Specification Section Number), materials of construction, dimensions, operating torque, valve end connection configuration, pressure rating, and operating temperature range.
   4. An amended Detailed Valve Specification for all valve types provided for this contract. Indicate with check marks where the valve supplied meets the requirements specified and with written amendments where the product differs from the specification.
   5. Factory Acceptance Test results and/or Certified Statement of Proof-of-Design testing results when specified in Detailed Valve Specifications.
   6. Action Submittal Items listed on Detailed Valve Specifications

B. Informational Submittals:
   1. Affidavits and registration numbers as specified.
   2. Operating and Maintenance data for incorporation in operation and maintenance manual, as specified in Section 01 78 23. Include complete description of operation together with detailed drawings, a complete list of replacement and repair parts, and parts manufacturer's identifying numbers.
   3. Informational Submittal Items listed on Detailed Valve Specifications.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Deliver valves to site in accordance with Section 01 66 00 and using loading methods which do not damage any valve components or coatings.

C. Tag loose valves as specified in Section 01 66 00, stating size, type, coatings and mating parts shipped loose or separate.

D. Store on site until ready for incorporation in the work using methods recommended by the manufacturer to prevent damage, undue stresses, or weathering.

1.06 WARRANTY

A. Where a warranty duration is specified by the Detailed Valve Specification, provide a special warranty valid for the specified duration.

B. Where no special warranty requirements are specified in the Detailed Valve Specification, provide manufacturer's standard warranty.

PART 2 PRODUCTS

2.01 VALVE CONFIGURATION REQUIREMENTS

A. General
   1. Provide valves of the same type, size range and service from a single manufacturer.
   2. Provide new, unused valves for the work.
   3. Provide valve materials free from defects or flaws, with true alignment and bores.
   4. Provide valves that open by turning the valve shaft to rotate counter-clockwise unless otherwise specified in the Detailed Valve Specification Section.

B. Provide padlockable lockout feature on all valves.

C. Manual Operators
   1. Provide valves with manual operators as specified in the Detailed Valve Specification, unless specified otherwise in Section 40 06 20.13.
   2. For hand wheels, clearly show the direction of opening in raised lettering and symbols.
   3. The maximum rim pull on a hand wheel is not to exceed 65 lb. when one side of the valve is at test pressure and the other side is at atmospheric pressure. Where a shaft mounted hand wheel would require greater force to operate, provide a torque reduction gearbox operator. Unless different operators are scheduled or specified on the Drawings, conform to the following minimum requirements.
   4. Provide 6 (total) eight-point operating wrenches for use on all valves with square nut operators.
   5. Quarter turn lever operators are to be perpendicular to the pipe runs when the valves are closed.
   6. Provide butterfly valves with 10 position latching levers except where used to balance air flows. Where used to balance air flows provide infinite position, screw down levers.
   7. The maximum pull at the end of the lever arm is not to exceed 65 lb. when one side of the valve is at test pressure and other side is at atmospheric pressure. Where greater force would be required to operate the valve with a lever, provide a torque reduction gearbox operator.
   8. Provide grease lubricated, worm gear type operators for torque reduction gearbox operators. Gearbox operators equipped with a hand wheel and a visual indicator of the valve position. Provide gear operators with adjustable mechanical stop-limiting devices to prevent over travel of the disc/ball/plug in the open and closed positions and which are self-locking and designed to hold the valve in any intermediate position between full open and full closed. Where gearbox operators are intended for direct bury or submergence, seal units with long life lubricant.

9. For manual valves on lines 3 inches and greater, mounted over 7.0 feet above the operating floor, provide chain wheel gear operators. Design chain wheel operators so that a force of 30 lb. is sufficient to open the valve when one side of the valve is at test pressure and the other side is at atmospheric pressure. Provide chain pulley that positively engages the chain links. The chain will extend from the valve operator to an operating height of 4 feet above the floor or as directed by the Owner. The exact dimensions will be field determined. Provide approved chain hooks where required to prevent chain from hanging within traffic paths.
10. Where manual operators are installed over 7.0 feet above the operating floor and the Drawings specify a vertical valve shaft, revise the gear operator and/or chain wheel position to provide a horizontal chain wheel shaft. Retain the valve orientation specified on the Drawings.
11. Provide ductile iron chain wheels. Provide galvanized steel operating chains.

D. Valve Stem Extensions and Wrench Nuts
   1. Provide valve stem extensions where additional clearance is required for pipe insulation or where valve operation without the extension is difficult; and in manholes.
   2. Where angle valve stem extensions are employed, they will be angle geared. Universal joint types are not permitted.
   3. Wrench nuts shall comply with AWWA C500. A minimum of two operating keys, but no less than one key per every ten valves, shall be provided for operation of wrench nut operated valves.

E. Operator Appurtenances
   1. Valve Boxes: Valve boxes shall be cast iron and shall have suitable base castings to fit properly over the bonnets of their respective valves and heavy top sections with stay-put covers. Covers shall be hot-dip galvanized. Valve boxes extending to finished surfaces shall be provided for buried valves.
   2. Floor Boxes: Floor boxes shall be hot-dip galvanized. Where the operating nut is in the concrete slab, the floor box shall be bronze bushed. Where the operating nut is below slab, the opening in the bottom of the box shall be sufficient for passage of the operating key. Floor boxes shall be provided for wrench operation of valves located below concrete slabs. Each floor box and cover shall be of the depth required for installation in the slab.
   3. Adjustable Shaft Valve Boxes: Adjustable shaft valve boxes shall be concrete or cast iron Brooks No. 3RT, Christie G5, Empire 7-1/2 valve extension box, or equal. Box covers on water lines shall be impressed with the letter "W." Gas line covers shall be impressed with the letter "G."

2.02 VALVE IDENTIFICATION TAGS

A. Provide valve identification tags for all valves with an identification tag number on the drawings (Mechanical and P&ID drawings).

B. Match tag numbers shown on the drawings.

C. General: Type 316 stainless steel tags, minimum 2.5-inches x 0.75 inches, with 0.1875 inch numbers and letters. Complete tag number shall be embossed on the tag. Tags shall be attached using stainless steel wire.

D. Chemical Service: Engraved Micro-surface Impact Acrylic, minimum 0.0625-inches thick, minimum 2.5-inches wide x 0.75 inches height. Colors to match pipe tag color scheme per Section 40 05 02. Tags shall be attached using plastic zip ties.

PART 3 EXECUTION

3.01 PREPARATION

A. The valve and piping arrangement indicated on the Drawings is based on typical dimensions for valves of the specified type. Make the necessary modifications in the piping to allow for discrepancies between the valve dimensions shown and those supplied for the Work.

B. Prior to installation of valves, field measure and check all equipment locations, pipe alignments, and structural installations. Ensure that the valve location and orientation provides suitable access to manual operators and that sufficient space and accessibility is available for hydraulic, pneumatic, and electric power actuators.

C. Where conflicts are identified, inform the Owner.

3.02 INSTALLATION

A. Install valves in conjunction with the piping specified in the Piping System Schedules (Sections 40 05 02.01 through 40 05 02.99), and with control valves and their appurtenances specified in Section 40 06 20.13.

B. In horizontal pipe runs, other than in locations where space does not permit, install all valves (except for butterfly valves, eccentric plug valves, and trunnion ball valves) with a vertical operating shaft with the actuator at the top. In no case install a valve with the operator below the valve.

C. Unless otherwise specified on the drawings, install butterfly valves, eccentric plug valves, and trunnion ball valves with the shaft in a horizontal orientation. Install eccentric plug valves with the plug above the valve shaft centerline when the valve is full open.

D. When joining valves to pipe or fittings, do not over torque bolts to correct for misalignment.

E. Support valves in position using temporary supports until valves are fixed in place.

F. Permanently support valves to prevent transmission of loads to adjacent pipework and/or equipment.

G. Where valves are installed in plastic pipelines (PVC, CPVC, HDPE, polypropylene etc.) greater than 4-inch diameter, support valves independent of the piping and brace valves against operating loads and torque to prevent transmission of stresses to the adjacent pipework.

H. Install gate valves in the closed position.

I. Install valves which are bubble tight in one direction to provide bubble tight seal of flow in normal direction of flow unless otherwise noted or directed by the Owner.

J. Unless otherwise specified, install single seated valves with the seat downstream. Install valves at tank connections with seat away from tank. Install valves on pump discharge and suction lines with seat end towards the pump.

K. Install all valves in accordance with the manufacturer's recommendations.

L. Protect valves installed below grade with a shrink sleeve or polyethylene sheath attached to the pipe with tape wrap.

M. Wrench nuts shall be provided on buried valves, on valves which are to be operated through floor boxes, and where specified. Extended wrench nuts shall be provided if necessary so that the nut will be within 6 inches of the valve box cover.

3.03 FIELD QUALITY CONTROL

A. Field or Site Tests and Inspections per Detailed Valve Specifications.

B. Pressure test all valves in conjunction with the pipes in which the valves are installed at test pressures specified in the applicable Piping System Schedule.

END OF SECTION

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SECTION 40 05 61.05

GATE VALVE - RESILIENT WEDGE [AWWA C509/515]

GENERAL

1. Line Size: 2 through 12 inches
2. Rated Limits: Pressure 350 psi; Temperature 160 °F
3. Reference Standard: AWWA C509 or 515
4. This specification is for gate valves with interior service. For buried gate valves, see Section 33 11 13.

VALVE MATERIALS

1. Body: Ductile Iron
2. Disc: Ductile Iron
3. Disc Coating: EPDM or SBR
4. Shaft: Stainless Steel or Manganese bronze
5. Hardware: Stainless steel
6. Coating: Fusion-bonded epoxy

VALVE CONFIGURATION

1. Valve End/Connections: Flanged, ANSI B16.1 Class 250
2. Type of Disc: Vulcanized Resilient Wedge
3. Operator: Handwheel

SUBMITTALS

1. As required in Section 40 05 60 – Valves.
2. Manufacturer's standard product data.
3. NSF/ANSI 61 Certification.

CANDIDATE MANUFACTURERS

1. Mueller A-2361 or A-2362
2. Kennedy Series 5000

END OF SECTION

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SECTION 40 05 62.02

PLUG VALVE - FULL PORT [AWWA C517]

GENERAL

1. Line Size: 3 through 12 inches
2. Rated Limits: Pressure 175 psi; Temperature 125 °F

VALVE MATERIALS

3. Body: Cast Iron or Ductile Iron
4. Plug: Cast Iron or Ductile Iron
5. Plug Facing: Neoprene or Buna-N
6. Seatings: 90% Ni or SS Overlay
7. Packing: Buna V-flex or TFE
8. Bearings: Stainless Steel; permanently lubricated bearings
9. Grit Excluder: PTFE or Buna-N

VALVE CONFIGURATION

1. Valve End/Connections: ANSI B16.1 Class 125# Flange
2. Pattern: One-piece, Full (100%) Port; valve shall have a port area of 100% area of adjacent pipe
3. Reference Standard: AWWA C517
4. Installation: install with shaft in horizontal position, valve seat located upstream.
5. Operator:
   a. Manual Lever/Handwheel; provide lever for valves 4 inches and smaller, totally enclosed worm gear for valves 6 inches and larger, operator components shall be sized in accordance with AWWA C504 Section 3.8
   b. Electric Modulating Actuator; provide modulating actuator for control valves where indicated on process and instrumentation diagrams (P&IDs).
6. Special: upper and lower journal bearings shall be replaceable, sleeve-type, corrosion resistant, and permanently lubricated; packing shall be self-adjusting chevron type replaceable without disassembling the valve.

SUBMITTALS

1. As required in Section 40 05 60 – Valves.
2. Furnish three certified copies of a report from an independent testing laboratory certifying successful completion of proof-of-design testing conducted in accordance with AWWA C517, Section 5.2. In lieu of testing the valves at an independent testing laboratory, proof-of-design testing may be performed at the valve manufacturer's laboratory but must be witnessed by a representative of a qualified independent testing laboratory, and all test reports must be certified by the laboratory representative. Proof-of-design testing shall have been performed on not less than three 6-inch diameter valves, with all three test units demonstrating full compliance with the test standards. Failure to satisfactorily complete the test shall be deemed sufficient evidence to reject all valves of the proposed make or manufacturer's model number.
3. Manufacturer’s standard product data.
4. NSF/ANSI 61 Certification

CANDIDATE MANUFACTURERS

1. DeZurik, PEC (2”), PEC or PEF (3” through 12”).
2. Clow Valve
3. Val Matic, Cam-Centric Series

END OF SECTION

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40 05 63.03

BALL VALVE - FULL PORT [SS]

GENERAL

1. Line Size: ¼ through 3 inches
2. Rated Limits: Pressure 1000 psi; Temperature 100 °F (WOG)

VALVE MATERIALS

1. Body: A351-CF8M Stainless Steel
2. Ball: A276-316 Stainless Steel
3. Seats: RPTFE
4. Packing: MPTFE
5. Stem: A26-316 Stainless Steel blowout-proof stem design

VALVE CONFIGURATION

1. Valve End/Connections: Threaded, Female NPT (ASME B1.20.1)
2. Pattern: Full Port
3. Ball Mount: Floating
4. Manual Operator: Lever/Handwheel

SUBMITTALS

1. As required in Section 40 05 60 – Valves.
2. Manufacturer's standard product data
3. NSF/ANSI 61 Certification

CANDIDATE MANUFACTURERS

1. Apollo 76J-100
2. Bray 7000
3. Approved Equal

END OF SECTION

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40 05 63.06

BALL VALVE - FULL PORT [CPVC]

GENERAL

1. Line Size: ½ through 4 inches
2. Rated Limits: Pressure 130 psi; Temperature 140 °F

VALVE MATERIALS

1. Body: CPVC; ASTM D1784 (Grade A)
2. Ball: CPVC; ASTM D1784 (Grade A)
3. O-Rings: FKM
4. Seats: PTFE
5. Shafts: CPVC; ASTM D1784 (Grade A), Blowout-proof ball and stem

VALVE CONFIGURATION

1. Valve End/Connections: Threaded, Female, True Union; ASTM D2464
2. Pattern: Full Port; bi-directional
3. Ball Mount: Floating
4. Manual Operator: Lever

SUBMITTALS

1. As required in Section 40 05 60 – Valves.
2. Manufacturer's standard product data.
3. Manufacturer's data indicating acceptable for use with intended fluid service.
4. NSF/ANSI 61 Certification.

CANDIDATE MANUFACTURERS

5. Hayward, TBH Series
6. Asahi America, T-21 Series
7. Approved Equal

END OF SECTION

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40 05 64.01

BUTTERFLY VALVE - RESILIENT SEATED

GENERAL

1. Line Size: 2 through 24 inches
2. Rated Limits: Pressure 150 psi; Temperature 250 °F (In-Line)
   Pressure 50 psi; Temperature 250 °F (Dead-End)

VALVE MATERIALS

1. Body: Cast Iron or Ductile Iron
2. Disc: Cast Iron or Ductile Iron
3. Shaft: Stainless Steel (316)
4. Disc Trim: Nickel or Nylon 11
5. Seat/Seal: EPDM or Viton/FKM

VALVE CONFIGURATION

1. Valve End/Connections: Flanged, ANSI B16.1 Class 125
2. Manual Operator: Lever/Handwheel; provide geared operators for valves 6 inches and larger

SUBMITTALS

1. As required in Section 40 05 60-Valves.
2. Manufacturer's standard data including product literature, materials of construction, construction details of equipment, and weight of equipment.
3. Affidavits of compliance with AWWA C504.
4. Documentation of compliance with ANSI/NSF 61

CANDIDATE MANUFACTURERS

1. Bray Series 31
2. Dezurik BOS-CL
3. Watts (D)BF-03

END OF SECTION

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40 05 64.03

BUTTERFLY VALVE - HIGH PERFORMANCE

GENERAL

1. Line Size: 2 through 48 inches
2. Rated Limits: Pressure 125 psi; Temperature 450 °F

VALVE MATERIALS

1. Body: Stainless Steel (316 or 317) -OR- Cast iron, ductile iron, or carbon steel with high-temperature epoxy coating.
2. Disc: Stainless Steel (316 or 317)
3. Disc Trim: Stainless Steel (316 or 317)
4. Seats: RPTFE/PTFE
5. Shaft: Stainless Steel (316, 17-4PH, or XM-19)
6. Packing: Graphite or PTFE V-Ring
7. Bearings: 316 SS-backed PTFE

VALVE CONFIGURATION

1. Valve End/Connections: Lugged or Flanged, ANSI B16.1 Class 150
2. Type of Disc: Eccentric Mount
3. Manual Operator: Lever/Handwheel; provide geared operators for valves 6 inches and larger

SUBMITTALS

1. As required in Section 40 05 60 - Valves
2. Manufacturer's data including product literature, materials of construction, construction details of equipment, wiring diagrams, and weight of equipment.
3. NSF/ANSI 61 Certification

CANDIDATE MANUFACTURERS

1. Dezurik BHP
2. Bray McCannalok Series 41
3. Crane Flo-Seal
4. Fisher 8580

END OF SECTION

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40 05 65.06

CHECK VALVE - SILENT

GENERAL
1. Line Size: 2 through 10 inches 2. Rated Limits: Pressure 150 psi; Temperature 150 °F
VALVE MATERIALS
1. Body: Cast Iron or Ductile Iron 2. Plug: Bronze 3. Seats: Bronze 4. Screw: Stainless Steel (316) 5. Spring: Stainless Steel (316) 6. Bushing: Bronze
VALVE CONFIGURATION
1. Valve End/Connections: Wafer 2. Check Mechanism: Plug, Silent Check 3. Body: Full Port
SUBMITTALS
1. Submittals as specified in Section 40 05 60 – Valves 2. Manufacturer's standard product data 3. NSF/ANSI 61 Certificate
CANDIDATE MANUFACTURERS
1. APCO 300 2. Val-Matic Series 1400A

END OF SECTION

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40 05 65.11

CHECK VALVE - SPLIT DISK

GENERAL

1. Line Size: 2 through 12 inches
2. Rated Limits: Pressure 175 psi; Temperature 250 °F
1. Line Size: 14 through 24 inches
2. Rated Limits: Pressure 125 psi; Temperature 250 °F
1. Line Size: 30 through 48 inches
2. Rated Limits: Pressure 85 psi; Temperature 250 °F

VALVE MATERIALS

1. Body: Cast Iron; all ferrous interior body surfaces not covered by elastomer shall be provided with interior epoxy lining compliant with AWWA C550
2. Disc: Aluminum Bronze or Stainless Steel (316)
3. Seals: Bronze, Viton A, or FKM
4. Hinge Pin: Stainless Steel (316)
5. Spring: Stainless Steel (316) or Inconel X-750

VALVE CONFIGURATION

1. Valve End/Connections: Wafer or Lug, ANSI B16.1 Class 125
2. Check Mechanism: Split Disc/Double Leaf
3. Special: provide lifting lugs on valves greater than 100 lb., valves shall open with not more than 0.5 psig differential pressure and be sprung such that the doors shut without slamming

SUBMITTALS

1. Submittals as specified in Section 40 05 60 – Valves
2. Manufacturer's standard product data
3. NSF/ANSI 61 Certification

CANDIDATE MANUFACTURERS

1. APCO 9000
2. Stockham WG-961
3. Stockham WG-970
4. Gulf Model MB
5. Crane Duo-Check

END OF SECTION

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40 05 65.26

CHECK VALVE - SWING

GENERAL

1. Line Size: ¾ through 8 inches
2. Rated Limits: Pressure 70 psi; Temperature 73 °F

VALVE MATERIALS

1. Body: Polypropylene or CPVC, ASTM D1784
2. Bonnet: Polypropylene or CPVC, ASTM D1784
3. Disc: Polypropylene or CPVC, ASTM D1784
4. Seats, Gasket: FKM
5. Hinge Pin: Polypropylene or CPVC, ASTM D1784
6. Fasteners: Stainless Steel (316)

VALVE CONFIGURATION

1. Valve End/Connections: Flange, ANSI Class 150
2. Type: Bonneted Flap Style Check

SUBMITTALS

1. Submittals as specified in Section 40 05 60 – Valves
2. Manufacturer's standard product data
3. NSF/ANSI 61 Certification

CANDIDATE MANUFACTURERS

1. Hayward SW Series
2. Asahi
3. Spears

END OF SECTION

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SECTION 40 05 65.31

CHECK VALVE - ELASTOMETRIC FLAP

GENERAL

1. Line Size: 2 through 48 inches
2. Rated Limits: Pressure 250 psi; Temperature 100 °F

VALVE MATERIALS

1. Body: Ductile Iron, ASTM A536 Grade 65-45-12
2. Disc: ASTM A36 steel encapsulated in elastomer
3. Disc coating and flexible flap: Reinforced Nitrile/NBR/Buna-N or Reinforced EPDM
4. Lining and Coating: NSF 61 compliant epoxy
5. Seat: Welded Nickel seat on Valve body
6. Disc Position Indicator: Lead Free Bronze and Stainless Steel
7. Nuts, Bolts, Hardware, and Fasteners: Stainless Steel
8. Backflow Actuator: Lead Free Bronze and Stainless Steel

VALVE CONFIGURATION

1. Design, Manufacture, and Testing: AWWA C508
2. Valve End/Connections: Flanged, ASME B16.1 Class 125
3. Pattern: Swing Check with short disc stroke and flexible flap
4. Disc and flexible flap: One piece construction, rigid disc
5. Rubber flap check valve with flexible flap connection between the disc and valve body. Flexure of the flap connection between the disc and valve body permits disc travel through an arc of motion not exceeding 40 degrees. Hinged or pinned discs are specifically prohibited.
6. Short disc stroke provides rapid valve closure to prevent valve slam.
7. Designed for low head loss and clog free operation. Valve port area not less than cross section area of connecting pipe.
8. Drop tight disc seating. Valve seat plane at 45-degree angle from the axis of the connecting pipe.
9. Equipped with Backflow Actuator and a Mechanical Disc Position Indicator. Backflow Actuator manually lifts the disc off the valve seats to permit backflow through the valve.

SUBMITTALS

1. Submittals as specified in Section 40 05 60 – Valves
2. Manufacturer's standard product data
3. NSF/ANSI 61 Certification

CANDIDATE MANUFACTURERS

1. APCO CRF-100A
2. Valmatic Swing-Flex
3. Or Approved Equal

END OF SECTION

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40 05 66.23

NEEDLE VALVE

GENERAL
1. Line Size: 1/8 through 3/8 inches 2. Rated Limits: Pressure 2580 psi; Temperature 200 °F
VALVE MATERIALS
1. Body: Stainless Steel (316) 2. Stem: Stainless Steel (316) 3. Seats: Stainless Steel (316) 4. Seals/Packing: PTFE or Reinforced PTFE
VALVE CONFIGURATION
1. Valve End/Connections: Threaded, Female or Compression 2. Flow Pattern: Straight 3. Stem Design: Vee 4. Operator: Screwed Bonnet, Round Handle
SUBMITTALS
1. As required in Section 40 05 60 – Valves. 2. Manufacturer's standard product data 3. NSF/ANSI 61 Certificate
CANDIDATE MANUFACTURERS
1. Swagelok 2. Parker 3. Approved Equal

END OF SECTION

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SECTION 40 05 67.13

REDUCED-PRESSURE ZONE BACKFLOW PREVENTERS FOR PROCESS SERVICE

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies reduced pressure principle backflow preventers.

B. Equipment List:
   1. Backflow preventers shall be as follows:

Equipment No.	Connection size, inch	Capacity, gpm	Max pressure loss, psi
BFPV2300A	6.00	70	5.0
BFPV2700A	2.00	700	5.0

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AWWA C511	Standard for Reduced-Pressure Principle Backflow Prevention Assembly

B. Testing:
   1. Backflow preventers shall meet the factory, laboratory and field test provisions of AWWA C511.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section. Candidate manufacturers include Cla-Val, Febco, Watts, or equal.

2.02 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Affidavit of Compliance with AWWA C511.
   2. Certificate of Approval as specified in AWWA C511.
   3. NSF/ANSI 61 Certification

PART 3 EXECUTION

3.01 INSTALLATION

A. Backflow preventers shall be installed in accordance with the manufacturer's instructions.

END OF SECTION

SECTION 40 05 67.33

BACKPRESSURE REGULATING VALVES

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies direct acting and pilot controlled backpressure regulating valves for water, air and chemical service.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.5	Pipe Flanges and Flanged Fittings

3. Additional Sections and Paragraphs Required for Compliance:
   a. The equipment specified in this section shall be provided in accordance with the following additional sections and paragraphs. This is not a comprehensive list of related and referenced sections and paragraphs and additional related and referenced sections and paragraphs requiring compliance may be specified throughout this section and within other sections.
      1) Section 01 33 00 – Submittal Procedures.
      2) Section 01 99 90 – Reference Forms.
      3) Section 43 05 11 - General Requirements for Equipment.

B. Performance:

1. Direct acting type pressure regulating valves shall control the upstream pressure within ±5 percent of set pressure.
2. Pilot controlled type pressure regulating valves shall maintain the set upstream pressure regardless of fluctuations in downstream pressure.

C. Testing:
   1. Hydrostatic tests shall be conducted by the manufacturer for one valve of each type supplied for a particular service. Steel-bodied valves shall be hydrostatically tested in accordance with the requirements of ANSI B16.5. Aluminum-, bronze-, and brass-bodied valves shall be hydrostatically tested at double the MAX pressure specified. Leakage, sweating or visible deformation at any point on the valve shall be cause for rejection of valves of that type and manufacture.

1.03 SUBMITALS

A. As required in Section 40 05 60 – Valves.

B. Action Submittals:
   1. Procedures: Section 01 33 00 – Submittal Procedures
   2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Manufacturers' product data, catalog cuts, typical installation details, and dimensions. Indicate on the submittal each piping system where the product will be used.

C. Information Submittals:
   1. Procedures: Section 01 33 00 – Submittal Procedures
   2. The Contractor shall provide certified copies of test reports specified in paragraph 1.02 Testing.

PART 2 PRODUCTS

2.01 REQUIREMENTS

A. General:
   1. Backpressure regulating valves shall be of flanged or threaded connections as specified. Moving parts requiring lubrication shall have means provided for lubrication and shall be lubricated prior to delivery.

B. Backpressure Regulating Valves (1 ½" and Larger)(Water Service):
   1. Backpressure valves for water service shall apply a continuous discharge backpressure downstream of the raw water feed pumps and serve as anti-siphoning valves. Backpressure valves shall be pilot controlled type and diaphragm actuated type or differential piston pressure type. Valves shall match line size as shown on drawings. Valves shall be adjustable and shall meet the requirement outlined in the Valve Schedule provided in Section 4.01. Anti-Cavitation trim kits shall be provided as necessary. Set pressure shall be selected based on pump curve to ensure pump remains in acceptable region in all operating conditions.
   2. Backpressure valves shall be Cla-Val or GA Industries.
      a. Valve body:
         1) Ductile Iron (with NSF-61 Approved Coating and Lining)
         2) Cast Steel (with NSF-61 Approved Coating and Lining)
      b. Seals
         1) FKM/Viton
      c. Diaphragm
         1) FKM/Viton

C. Backpressure Regulating Valves (1 ½" and Smaller)(Chemical):
   1. Backpressure valves for chemical service shall apply a continuous discharge backpressure downstream of the metering pumps and serve as anti-siphoning valves. Backpressure valves shall be non-metallic and suitable for the pumped liquid characteristics. Backpressure valves shall match line size as shown on drawings. Backpressure valves shall be adjustable from 10-150 psi with a tamper-resistant adjustment screw. The valves shall be as close to the pump discharge as feasible, but downstream of pulsation dampeners and pressure gauges. Adjustable diaphragm backpressure regulating type valves shall be installed on pump discharge as shown on the drawings. Valve shall be suitable for the chemical solution service specified.
   2. Backpressure valves shall be Griffco, Plast-O-Matic, or equal.
      a. Valve body:
         1) CPVC
         2) Approved Eqal
      b. Seals
         1) FKM/VIton

2.02 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Manufacturer's product data.
   2. Hydrostatic test results.
   3. ANSI/NSF-61 Certificate

PART 3 EXECUTION

3.01 INSTALLATION

A. Backpressure regulating valves shall be installed in accordance with the manufacturer's recommendations.

PART 4 SCHEDULE

4.01 BACKPRESSURE REGULATING VALVES SCHEDULE (2" AND ABOVE)

Valve number	Service	Valve size (inches)	Maximum flow, (gpm)	Set Point (psig)	Inlet Pressure Range (psig)	Outlet Pressure Range (psig)
BPRV2110A	RW	6.00"	680	Based on Pump Curve	Set Point to 55	0 to 55
BPRV2120A	RW	6.00"	680	Based on Pump Curve	Set Point to 55	0 to 55

END OF SECTION

SECTION 40 05 67.36

PRESSURE REGULATING VALVES

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies direct acting and pilot controlled pressure regulating valves for water, air and chemical service including pressure regulating/relief valves (PRVs) and pressure safety valves (PSVs).

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.5	Pipe Flanges and Flanged Fittings

3. Additional Sections and Paragraphs Required for Compliance:
   a. The equipment specified in this section shall be provided in accordance with the following additional sections and paragraphs. This is not a comprehensive list of related and referenced sections and paragraphs and additional related and referenced sections and paragraphs requiring compliance may be specified throughout this section and within other sections.
      1) Section 01 33 00 – Submittal Procedures.
      2) Section 01 99 90 – Reference Forms.
      3) Section 43 05 11 - General Requirements for Equipment.

B. Performance:

1. Direct acting type pressure regulating valves shall control the discharge pressure within ±5 percent of set pressure.
2. Pilot controlled type pressure regulating valves shall maintain the set discharge pressure regardless of fluctuations in inlet pressure.

C. Testing:
   1. Hydrostatic tests shall be conducted by the manufacturer for one valve of each type supplied for a particular service. Steel-bodied valves shall be hydrostatically tested in accordance with the requirements of ANSI B16.5. Aluminum-, bronze-, and brass-bodied valves shall be hydrostatically tested at double the MAX pressure specified. Leakage, sweating or visible deformation at any point on the valve shall be cause for rejection of valves of that type and manufacture.

1.03 SUBMITALLS

A. As required in Section 40 05 60 – Valves.

B. Action Submittals:
   1. Procedures: Section 01 33 00 – Submittal Procedures
   2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Manufacturers' product data, catalog cuts, typical installation details, and dimensions. Indicate on the submittal each piping system where the product will be used.

C. Information Submittals:
   1. Procedures: Section 01 33 00 – Submittal Procedures
   2. The Contractor shall provide certified copies of test reports specified in paragraph 1.02 Testing.

PART 2 PRODUCTS

2.01 REQUIREMENTS

A. General:
   1. Pressure regulating valves shall be flanged or threaded connections as specified. Moving parts requiring lubrication shall have means provided for lubrication and shall be lubricated prior to delivery.

B. Pressure Safety Valves (PSVs):
   1. Valves for air service shall be ASME certified, Watts Figure 41A, Lonergan L14/L40 Series, or equal.

C. Pressure regulating/relief valves (PRVs).
    1. Chemical Service:
        a. Adjustable pressure relief type valves for chemical service shall be suitable for the chemical solution service specified and shall be installed on pump discharge at the feed panel as shown the drawings.
        b. Valves shall be sized to handle a maximum flow through the valves of not less than 1.5 times the maximum flow supplied by the associated pump.
        c. Pressure relief valves shall be Griffco, Plast-O-Matic, or equal.
            1) Valve body:
                a) CPVC
                b) Or Approved Equal
            2) Seals
                a) Viton/FKM

2.02 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
    1. Manufacturer's product data.
    2. Hydrostatic test results.
    3. ANSI/NSF-61 Certificate

PART 3 EXECUTION

3.01 INSTALLATION

A. Pressure regulating valves shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

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40 05 74.06

DIAPHRAGM VALVE, CPVC

GENERAL

1. Line Size: ½ through 3 inches
2. Rated Limits: Pressure 130 psi; Temperature 140 °F

VALVE MATERIALS

1. Body: CPVC; ASTM D1784
2. Diaphragm: PTFE; provide PVDF vapor barrier for sodium hypochlorite service
3. O-Rings: FKM; provide PTFE encapsulated, FKM, or Viton O-rings for sodium hypochlorite service and polymer service

VALVE CONFIGURATION

1. Valve End/Connections: Threaded, Female, True Union X Solvent Welded Socket
2. Pattern: Weir Type, Diaphragm Seat
3. Manual Operator: Handwheel

SUBMITTALS

1. As required in Section 40 05 60 – Valves.
2. Manufacturer's standard product data.
3. Manufacturer's data indicating acceptable for use with intended fluid service
4. NSF/ANSI 61 Certification.

CANDIDATE MANUFACTURERS

1. Hayward DAB Series
2. Asahi Type 14
3. Spears

END OF SECTION

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SECTION 40 05 78.13

AIR-VACUUM VALVES FOR WATER SERVICE

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies air release valves, air and vacuum valves, and combination air valves for clean water service, pumping, and storage applications.

B. Types:
   1. Air Release Valves: Air release valves (ARV) shall have a small venting orifice to vent the accumulation of air and other gases with the line or system under pressure. Size and capacity shall be as specified.
   2. Air and Vacuum Valves: Air and vacuum valves (AVV) shall have a large venting orifice to permit the release of air as the line is filling or relieve the vacuum as the line is draining or is under negative pressure. Size and capacity
   3. Combination Air Valves: Combination air valves (CAV) shall have operating features of both the air and vacuum valve and the air release valve. They include both single- and dual-body construction. Size and capacity shall be as specified.
   4. All air release valves, combination air valves and connection hardware shall be designed for a 300-psi working pressure.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A240	Heat-Resisting Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels

1.03 SCHEDULE

Valve number	Valve size, inches	Type	System press, PSI	Capacity, CFFAM/SCFS
All Vol. 3 pipeline	1-inch	Combination	300 psi	---

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. Air release and vacuum valves shall be APCO as manufactured by Valve and Primer Corporation, Crispin as manufactured by Multiplex Manufacturing Company, or equal, modified to provide the specified features and to meet the specified operating conditions.

2.02 MATERIALS

Component	Material
Body, cover	Cast iron, ASTM A126, Grade B
Float	Type 316 SS, ASTM A240
Seat	Buna-N or Type 316 SS
Trim	Type 316 SS, ASTM A240

A. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

2.03 CONSTRUCTION

A. Air release valves shall be float operated, compound lever type, except air release valves less than 1-inch may be simple lever type.

B. Air and vacuum valves shall be designed to protect the float from direct contact of the rushing air and water to prevent the float from closing prematurely in the valve. The seat shall be fastened into the valve cover, and shall be easily removed if necessary. The float shall be center or peripheral guided for positive shutoff into the seat.

C. Combination air valves, unless otherwise specified, shall be single-body construction in sizes 1- through 6-inch and dual-body construction in sizes 8-inch and larger. Single-body construction shall be designed to provide all functions within one housing. The body inlet shall be baffled to protect the float and the large and small orifices shall be designed so that during large orifice closure, the small air release orifice will open to allow small amounts of air to escape. Dual-body construction shall combine one air and vacuum valve and one air release valve with interconnecting piping and gate valve.

D. Air valves for vertical turbine pumps (sizes 3-inch and less) shall be designed and constructed as specified for air and vacuum valves except the discharge orifice shall be fitted with a throttling device to regulate and restrict air venting and establish a pressure loading on the rising column of water on pump start. Unless otherwise specified, air valves, 4-inch and larger, shall be dual body combination air valves except the inlet shall be fitted with a surge check to prevent water column entering the valve on pump start.

E. Valves shall be suitable for pressures up to 300 psi.

2.04 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Manufacturer's product data.
   2. Applicable O&M instruction manuals per Section 01 78 23.

PART 3 EXECUTION

3.01 INSTALLATION

A. Air release and vacuum valves shall be installed in accordance with the manufacturer's recommendations. Unless otherwise specified, isolation valves per Section 40 05 01 shall be provided below each air valve.

END OF SECTION

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40 05 82.01

SOLENOID VALVE – 2 WAY [2 POSITION]

GENERAL

1. Line Size: 3/8 through 2-1/2 inches
2. Rated Limits: Pressure 150 psi; Temperature 180 °F (Air)
   Pressure 125 psi, Temperature 180 °F (Water)

VALVE MATERIALS

1. Body: Stainless Steel (316)
2. Seal: PTFE/FKM
3. Disc: PTFE/FKM

VALVE CONFIGURATION

1. Valve End/Connections: Threaded
2. Operator: Solenoid, Normally opened/closed position per P&IDs.
3. Lining: None
4. Pattern: 2-Way/2-Position, Direct Acting and Internal Pilot Type; capable of sealing or unsealing the pressurized (supply) port when mounted in any position or orientation, furnish flow restriction on exhaust port to limit actuation speed, capable of opening or closing against the maximum differential pressure specified for the designated piping system, capable of opening or closing with a minimum operating pressure differential of 5 psi.
5. Solenoid Coil: Fully Encapsulated Class H Coil; continuous duty rating, 120 VAC
6. NEMA Enclosure, Type: 4X, UL 429 listed

SUBMITTALS

1. As required in Section 40 05 60 – Valves.
2. Manufacturer's standard product data.
3. Manufacturer's data indicating acceptable for use with intended fluid service
4. NSF/ANSI 61 Certification.

CANDIDATE MANUFACTURERS

1. Automatic Switch Company (ASCO) 8210
2. Honeywell Skinner

END OF SECTION

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SECTION 40 06 70

SCHEDULES FOR INSTRUMENTATION OF PROCESS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Instrument Index for instruments furnished or installed under Sections 40 71 00 through 40 75 00.

1.02 SUBMITTALS

A. Procedures: Section 01 33 00.

B. Submittal requirements: Section 40 61 13.

C. Action Submittal:
   1. Submit updated schedule with field instrumentation submittal to match equipment being provided.

PART 2 NOT USED

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to Section 40 61 13 for requirements.

3.02 FIELD QUALITY CONTROL

A. Refer to Section 40 61 21 for requirements.

B. Maintain a copy of the complete Instrument Index with modifications during construction in Excel format. Provide a copy of the latest version to the Construction Manager upon request.

3.03 ATTACHMENTS

A. 40 06 70 Attachment A: INSTRUMENT INDEX for each of the Intake PS, LeChee WTP, and LeChee PS No. 3.
   1. Description of headings in Instrument Index.

Instrument Field or Heading	Example	Comment or Description
Tag No. Function Abbreviation	PDIT	See P&ID sheet legend I-00-001.
Tag No. Area Code	01	See P&ID sheet legend I-00-004.
Tag No. Loop Identifier	23	See P&ID sheet legend I-00-001.
Device Function	Primary sludge Pump 1 Discharge flow	Provides the functional description of the instrument, analyzer, or device.

Instrument Field or Heading	Example	Comment or Description
Operating Range	25–65	25 to 65, -10 to 90, etc.
Setpoint	24	
Min Calibration	00	
Max Calibration	24.00	Include displayed decimal point.
Units	MGD	MGD, KW, PSIG, etc.
Comments	Class 1 Div 2 Area, Owner-supplied for installation by contractor. Provide grounding ring to match instrument.	Provides the features, interlocks, and information applicable to the instrument, analyzer, or device. Describes special installation instructions, area classifications, modifiers to standard instrument specs, Owner-supplied, existing, accessories, signal surge protection, options, etc.
Device Type	FM	Div. 40 Instruspec type or other name in specification listed below
Specification Number	40 71 00	Specification under which device is provided or specified.
P&ID Number	P-10-003	P&ID sheet number

END OF SECTION

Tag Function Abb.	Tag Loop Identifier	Device Function	Operating Range	Setpoint	Min Calibration	Max Calibration	Units	Comments	Device Type	Specification Number
TE/TIT		Electrical Room Temperature	NA	NA	0	150	°F		TRE, TMP	40 74 00
TSH		Moisture/Temperature Sensor: Stage 1 Pump 1	NA	Mfr	NA	NA	°F	[Vendor]	-	Div 43
PI		Discharge Pressure: Stage 1 Pumps	Mfr	NA	0	Mfr	psig		PT	40 73 00
TSH		Moisture/Temperature Sensor: Stage 1 Pump 2	NA	Mfr	NA	NA	°F	[Vendor]	-	Div 43
FE/FIT		Discharge Flow	0 - 600	NA	0	750	gpm		FM	40 71 00
PSH		Suction Pressure: Stage 2 Pumps	Mfr	NA	0	Mfr	psig		PT	40 73 00
PIT		Discharge Pressure: Stage 2 Pumps	Mfr	NA	0	Mfr	psig		PT	40 73 00

Tag Function Abb.	Tag Area Code	Tag Loop Identifier	Device Function	Operating Range	Setpoint	Min Calibration	Max Calibration	Units	Comments	Device Type	Specification Number	P&ID Number
TE/TIT	0	96	Electrical Room Temperature	35-140	-	0	150	°F		TRE, TMP	40 74 00	I-00-101
LSHH	0	95	Process Room Flood	-	3	-	-	inches		LFS2	40 72 00	I-00-101
FE/FIT	10	00A	Inlet flow - RW Tank [T1010]	0 - 1000	-	0	1000	gpm		FM	40 71 00	I-10-101
PIT	10	10A	Water Level - RW Tank [T1010]	0 - 30	-	0	30.00	ft		LGH	40 72 00	I-10-101
ZS	10	00A	Intrusion Switch - RW Meter Vault	-	-	-	-	NA		-	26 09 16	I-10-101
ZS	10	10A	Intrusion Switch - RW Tank [T1010]	-	-	-	-	NA		-	26 09 16	I-10-101
PI	21	10A	Suction Pressure: RW Feed Pump 1 [P2110]	FV - 30	-	-15	30	psig		PG	40 73 00	I-21-101
PI	21	10B	Discharge Pressure: RW Feed Pump 1 [P2110]	0 - 60	-	0	60	psig		PG	40 73 00	I-21-101
TSH	21	10A	Temperature Switch [High]: RW Feed Pump Motor 1 [P2110]	-	MFR	-	-	°F	[Vendor]	-	43 05 21	I-21-101
FE/FSL	21	10A	Flow Switch [Low]: RW Feed Pump 1 [P2110]	-	100	-	-	gpm		FTS	40 71 00	I-21-101
DPSH	21	15A	Differential Pressure Switch: RW Filter 1 [FLT2115]	-	8.5	-	-	psig	[Vendor]	-	46 61 33	I-21-101
PI	21	15A	Inlet Pressure: RW Filter 1 [FLT2115]	0 - 60	-	0	60	psig	[Vendor]	-	46 61 33	I-21-101
PI	21	15B	Discharge Pressure: RW Filter 1 [FLT2115]	0 - 60	-	0	60	psig	[Vendor]	-	46 61 33	I-21-101
PI	21	20A	Suction Pressure: RW Feed Pump 2 [P2120]	FV - 30	-	-15	30	psig		PG	40 73 00	I-21-101
PI	21	20B	Discharge Pressure: RW Feed Pump 2 [P2120]	0 - 60	-	0	60	psig		PG	40 73 00	I-21-101
TSH	21	20A	Temperature Switch [High]: RW Feed Pump Motor 2 [P2120]	-	MFR	-	-	°F	[Vendor]	-	43 05 21	I-21-101
FE/FSL	21	20A	Flow Switch [Low]: RW Feed Pump 2 [P2120]	-	100	-	-	gpm		FTS	40 71 00	I-21-101
DPSH	21	25A	Differential Pressure Switch: RW Filter 2 [FLT2125]	-	8.5	-	-	psig	[Vendor]	-	46 61 33	I-21-101
PI	21	25A	Inlet Pressure: RW Filter 2 [FLT2125]	0 - 60	-	0	60	psig	[Vendor]	-	46 61 33	I-21-101
PI	21	25B	Discharge Pressure: RW Filter 2 [FLT2125]	0 - 60	-	0	60	psig	[Vendor]	-	46 61 33	I-21-101
PI	21	30A	Suction Pressure: RW Feed Pump 3 [P2130]	FV - 30	-	-15	30	psig	[Future]	PG	40 73 00	I-21-101
PI	21	30B	Discharge Pressure: RW Feed Pump 3 [P2130]	0 - 60	-	0	60	psig	[Future]	PG	40 73 00	I-21-101
TSH	21	30A	Temperature Switch [High]: RW Feed Pump Motor 3 [P2130]	-	MFR	-	-	°F	[Vendor][Future]	-	43 05 21	I-21-101
FE/FSL	21	30A	Flow Switch [Low]: RW Feed Pump 3 [P2130]	-	100	-	-	gpm	[Future]	FTS	40 71 00	I-21-101
DPSH	21	35A	Differential Pressure Switch: RW Filter 3 [FLT2135]	-	8.5	-	-	psig	[Vendor][Future]	-	46 61 33	I-21-101
PI	21	35A	Inlet Pressure: RW Filter 2 [FLT2135]	0 - 60	-	0	60	psig	[Vendor][Future]	-	46 61 33	I-21-101
PI	21	35B	Discharge Pressure: RW Filter 2 [FLT2135]	0 - 60	-	0	60	psig	[Vendor][Future]	-	46 61 33	I-21-101
AE/AIT	22	00A	RW Feed Turbidity	0 - 100	-	0	100.0	NTU	[Vendor]	-	46 61 33	I-22-101
FE	22	00A	Sample Flow: RW Feed Turbidity [AIT2200A]	MFR	-	0	MFR	gph	[Vendor] - Paddle Wheel	-	46 61 33	I-22-101
PT	22	10A	Permeate Pressure: Membrane Skid 1	0 - 60	-	0	60.0	psi	[Vendor]	-	46 61 33	I-22-102
PT	22	10B	Membrane Integrity Test Pressure: Membrane Skid 1	0 - 15	-	0	15.0	psi	[Vendor]	-	46 61 33	I-22-102
PT	22	10C	RW Feed Pressure: Membrane Skid 1	0 - 60	-	0	60.0	psi	[Vendor]	-	46 61 33	I-22-102
PSH	22	10D	Pressure Switch [High]: Membrane Skid 1	-	50	-	-	psi	[Vendor]	-	46 61 33	I-22-102
TT	22	10A	Permeate Temperature: Membrane Skid 1	32 - 104	-	32.0	104.0	°F	[Vendor]	-	46 61 33	I-22-102
FIT	22	10A	RW Feed Flow: Membrane Skid 1	0 - 1100	-	0	1100	gpm	[Vendor]	-	46 61 33	I-22-102
AE/AIT	22	10A	Permeate Turbidity: Membrane Skid 1	0 - 100	-	0	100.0	NTU	[Vendor]	-	46 61 33	I-22-103
FE	22	10A	Sample Flow: Permeate Feed Turbidity [AIT2210A]	MFR	-	0	MFR	gph	[Vendor] - Paddle Wheel	-	46 61 33	I-22-103
PT	22	20A	Permeate Pressure: Membrane Skid 2	0 - 60	-	0	60.0	psi	[Vendor]	-	46 61 33	I-22-104
PT	22	20B	Membrane Integrity Test Pressure: Membrane Skid 2	0 - 15	-	0	15.0	psi	[Vendor]	-	46 61 33	I-22-104
PT	22	20C	RW Feed Pressure: Membrane Skid 2	0 - 60	-	0	60.0	psi	[Vendor]	-	46 61 33	I-22-104
PSH	22	20D	Pressure Switch [High]: Membrane Skid 2	-	50	-	-	psi	[Vendor]	-	46 61 33	I-22-104
TT	22	20A	Permeate Temperature: Membrane Skid 2	32 - 104	-	32.0	104.0	°F	[Vendor]	-	46 61 33	I-22-104
FIT	22	20A	RW Feed Flow: Membrane Skid 2	0 - 1100	-	0	1100	gpm	[Vendor]	-	46 61 33	I-22-104
AE/AIT	22	20A	Permeate Turbidity: Membrane Skid 2	0 - 100	-	0	100.0	NTU	[Vendor]	-	46 61 33	I-22-105
FE	22	20A	Sample Flow: Permeate Feed Turbidity [AIT2220A]	MFR	-	0	MFR	gph	[Vendor] - Paddle Wheel	-	46 61 33	I-22-105
PT	22	30A	Permeate Pressure: Membrane Skid 3	0 - 60	-	0	60.0	psi	[Vendor][Future]	-	46 61 33	I-22-106
PT	22	30B	Membrane Integrity Test Pressure: Membrane Skid 3	0 - 15	-	0	15.0	psi	[Vendor][Future]	-	46 61 33	I-22-106
PT	22	30C	RW Feed Pressure: Membrane Skid 3	0 - 60	-	0	60.0	psi	[Vendor][Future]	-	46 61 33	I-22-106
PSH	22	30D	Pressure Switch [High]: Membrane Skid 3	-	50	-	-	psi	[Vendor][Future]	-	46 61 33	I-22-106
TT	22	30A	Permeate Temperature: Membrane Skid 3	32 - 104	-	32.0	104.0	°F	[Vendor][Future]	-	46 61 33	I-22-106
FIT	22	30A	RW Feed Flow: Membrane Skid 3	0 - 1100	-	0	1100	gpm	[Vendor][Future]	-	46 61 33	I-22-106
AE/AIT	22	30A	Permeate Turbidity: Membrane Skid 3	0 - 100	-	0	100.0	NTU	[Vendor][Future]	-	46 61 33	I-22-107
FE	22	30A	Sample Flow: Permeate Feed Turbidity [AIT2230A]	MFR	-	0	MFR	gph	[Vendor][Future] - Paddle Wheel	-	46 61 33	I-22-107
FE/FIT	22	40A	BW Flow: BW Pump Skid	0 - 500	-	0	500	gpm		FM	40 71 00	I-22-108
PI	22	41A	Suction Pressure: BW Pump 1 [P2241]	FV - 30	-	-15	30	psig		PG	40 73 00	I-22-108
PI	22	41B	Discharge Pressure: BW Pump 1 [P2241]	0 - 100	-	0	100	psig		PG	40 73 00	I-22-108
TSH	22	41A	Temperature Switch [High]: BW Pump Motor 1 [P2241]	-	MFR	-	-	°F	[Vendor]	-	43 05 21	I-22-108
PSH	22	41B	Pressure Switch [High]: BW Pump 1 [P2241]	-	55	-	-	psig		PS	40 73 00	I-22-108
PI	22	42A	Suction Pressure: BW Pump 2 [P2242]	FV - 30	-	-15	30	psig		PG	40 73 00	I-22-108
PI	22	42B	Discharge Pressure: BW Pump 2 [P2242]	0 - 100	-	0	100	psig		PG	40 73 00	I-22-108
TSH	22	42A	Temperature Switch [High]: BW Pump Motor 2 [P2242]	-	MFR	-	-	°F	[Vendor]	-	43 05 21	I-22-108
PSH	22	42B	Pressure Switch [High]: BW Pump 2 [P2242]	-	55	-	-	psig		PS	40 73 00	I-22-108
LIT	22	40A	Level: BW Tank [T2240]	0 - 100	-	0	MFR	ft	[Vendor]	-	46 61 33	I-22-108
FE/FIT	22	50A	CIP Solution Flow: CIP Pump Skid	0 - 500	-	0	500	gpm		FM	40 71 00	I-22-109
PI	22	51A	Suction Pressure: CIP Pump 1 [P2251]	FV - 30	-	-15	30	psig		PG	40 73 00	I-22-109

Tag Function Abb.	Tag Area Code	Tag Loop Identifier	Device Function	Operating Range	Setpoint	Min Calibration	Max Calibration	Units	Comments	Device Type	Specification Number	P&ID Number
PI	22	51B	Discharge Pressure: CIP Pump 1 [P2251]	0 - 30	-	0	30	psig		PG	40 73 00	I-22-109
TSH	22	51A	Temperature Switch [High]: CIP Pump Motor 1 [P2251]	-	MFR	-	-	°F	[Vendor]	-	43 05 21	I-22-109
PSH	22	51B	Pressure Switch [High]: CIP Pump 1 [P2251]	-	55	-	-	psig		PS	40 73 00	I-22-109
PI	22	52A	Suction Pressure: CIP Pump 1 [P2251]	FV - 30	-	-15	30	psig		PG	40 73 00	I-22-109
PI	22	52B	Discharge Pressure: CIP Pump 1 [P2251]	0 - 30	-	0	30	psig		PG	40 73 00	I-22-109
TSH	22	52A	Temperature Switch [High]: CIP Pump Motor 1 [P2251]	-	MFR	-	-	°F	[Vendor]	-	43 05 21	I-22-109
PSH	22	52B	Pressure Switch [High]: CIP Pump 2 [P2252]	-	55	-	-	psig		PS	40 73 00	I-22-109
TT	22	50A	CIP Solution Temperature: CIP Skid	32 - 122	-	32	150	°F		TRE, TMP	40 74 00	I-22-109
TSH	22	55A	Temperature Switch [High]: CIP Heater [H2255]	-	176	-	-	°F	[Vendor]	-	46 61 33	I-22-109
TSH	22	50A	Temperature Switch [High]: CIP Solution	-	109	-	-	°F	[Vendor]	-	46 61 33	I-22-109
FSL	22	50A	Flow Switch [Low]: CIP Solution	-	100	-	-	gpm		FTS	40 71 00	I-22-109
LIT	22	50A	Level: CIP Tank [T2250]	0 - 100	-	0	MFR	ft	[Vendor]	-	46 61 33	I-22-109
AE/AIT	22	50A	Residual Chlorine: CIP Solution + Service Water	0 - 200	-	0	200	ppm	[Vendor] - Same AIT as AE2250B and AE2250C	-	46 61 33	I-22-110
AE/AIT	22	50B	pH: CIP Solution + Service Water	0 - 14	-	0	14.00	pH	[Vendor] - Same AIT as AE2250A and AE2250C	-	46 61 33	I-22-110
AE/AIT	22	50C	pH: CIP Solution	0 - 14	-	0	14.00	pH	[Vendor] - Same AIT as AE2250A and AE2250B	-	46 61 33	I-22-110
PI	22	60A	Discharge Pressure: Sodium Hypochlorite Pump [P2260 + P2261]	0 - 100	-	0	MFR	psig	[Vendor]	-	46 61 33	I-22-111
WE	22	60A	Weight: Sodium Hypochlorite Tank [T2260]	0 - 1000	-	0	1000	lbs	Same WIT as WE2262A, WE2264A, WE 2266A	-	46 61 33	I-22-111
PI	22	62A	Discharge Pressure: Citric Acid Pump [P2262 + P2263]	0 - 100	-	0	MFR	psig	[Vendor]	-	46 61 33	I-22-112
WE	22	62A	Weight: Citric Acid Tank [T2262]	0 - 1000	-	0	1000	lbs	Same WIT as WE2260A, WE2264A, WE 2266A	-	46 61 33	I-22-112
PI	22	64A	Discharge Pressure: Sodium Bilsulfate Pump [P2264 + P2265]	0 - 100	-	0	MFR	psig	[Vendor]	-	46 61 33	I-22-113
WE	22	64A	Weight: Sodium Bilsulfate Tank [T2264]	0 - 1000	-	0	1000	lbs	Same WIT as WE2260A, WE2262A, WE 2266A	-	46 61 33	I-22-113
PI	22	66A	Discharge Pressure: Surfuric Acid Pump [P2266 + P2267]	0 - 100	-	0	MFR	psig	[Vendor]	-	46 61 33	I-22-114
WE	22	66A	Weight: Sodium Surfuric Acid [T2264]	0 - 1000	-	0	1000	lbs	Same WIT as WE2260A, WE2262A, WE 2264A	-	46 61 33	I-22-114
PI	22	68A	Discharge Pressure: Sodium Hydroxide Pump [P2268 + P2269]	0 - 100	-	0	MFR	psig	[Vendor]	-	46 61 33	I-22-115
FSL	22	70A	Flow Switch [Low]: Air Scour Blowers	-	MFR	-	-	cfm	[Vendor] Flow/No Flow Signal	-	46 61 33	I-22-116
PI	22	71A	Discharge Pressure: Air Scour Blower 1 [B2271]	MFR	-	0	MFR	psig	[Vendor]	-	46 61 33	I-22-116
TSH	22	71A	Temperature Switch [High]: Air Scour Blower Motor 1 [B2271]	-	MFR	-	-	°F	[Vendor]	-	43 05 21	I-22-116
PI	22	72A	Discharge Pressure: Air Scour Blower 2 [B2272]	MFR	-	0	MFR	psig	[Vendor]	-	46 61 33	I-22-116
TSH	22	72A	Temperature Switch [High]: Air Scour Blower Motor 2 [B2272]	-	MFR	-	-	°F	[Vendor]	-	43 05 21	I-22-116
PI	22	80A	Tank Pressure: Compressor Tank [T2280]	MFR	-	0	MFR	psig	[Vendor]	-	46 61 33	I-22-117
DPI	22	80B	Differential Air Pressure: Primary Filter	MFR	-	0	MFR	psig	[Vendor]	-	46 61 33	I-22-117
DPI	22	80A	Differential Air Pressure: Secondary Filter	MFR	-	0	MFR	psig	[Vendor]	-	46 61 33	I-22-117
PI	22	80B	Tank Pressure: Compressor Tank [T2280]	MFR	-	0	MFR	psig	[Vendor]	-	46 61 33	I-22-117
PSL	22	80A	Pressure Switch [Low | High]: Compressor Tank [T2280]	-	110 | 145	-	-	psig	[Vendor]	-	46 61 33	I-22-117
PSL	22	80B	Pressure Switch [Low]: Instrumentation Air Supply	-	90	-	-	psig	[Vendor]	-	46 61 33	I-22-117
PSL	22	80C	Pressure Switch [Low Low]: Instrumentation Air Supply	-	70	-	-	psig	[Vendor]	-	46 61 33	I-22-117
FIT	23	00A	Influent Flow: GAC System	0 - 1100	-	0	1100	gpm		FM	40 71 00	I-23-101
FIT	23	00B	Bypass Flow: GAC System	0 - 1100	-	0	1100	gpm		FM	40 71 00	I-23-101
PI	23	00A	Suction Pressure: GAC Backwash Pump [P2300]	FV - 30	-	-15	30	psig		PG	40 73 00	I-23-101
PI	23	00B	Discharge Pressure: GAC Backwash Pump [P2300]	0 - 60	-	0	60	psig		PG	40 73 00	I-23-101
PSH	23	00A	Pressure Switch [High]: GAC Backwash Pump [P2300]	-	MFR	-	-	psig		PS	40 73 00	I-23-101
TSH	23	00A	Temperature Switch [High]: GAC Backwash Pump Motor [P2300]	-	MFR	-	-	°F	[Vendor]	-	43 05 21	I-23-101
DPS	23	10A	Differential Pressure Switch [High]: GAC Filter 1 [PV2310]	0 - 60	MFR	-	-	psig	[Vendor]	-	43 31 13.13	I-23-101
AE/AIT	23	10A	Filtrate Turbidity: GAC Filter 1 [PV2310]	0 - 100	-	0	100.0	NTU	[Vendor]	-	43 31 13.13	I-23-101
PI	23	10A	Inlet Pressure: GAC Filter 1 [PV2310]	0 - 60	-	0	60	psig	[Vendor]	-	43 31 13.13	I-23-101
PI	23	10B	Outlet Pressure: GAC Filter 1 [PV2310]	0 - 60	-	0	60	psig	[Vendor]	-	43 31 13.13	I-23-101
DPS	23	20A	Differential Pressure Switch [High]: GAC Filter 2 [PV2320]	-	MFR	-	-	psig	[Vendor]	-	43 31 13.13	I-23-102
AE/AIT	23	20A	Filtrate Turbidity: GAC Filter 2 [PV2320]	0 - 100	-	0	100.0	NTU	[Vendor]	-	43 31 13.13	I-23-102
PI	23	20A	Outlet Pressure: GAC Filter 2 [PV2320]	0 - 60	-	0	60	psig	[Vendor]	-	43 31 13.13	I-23-102
DPS	23	30A	Differential Pressure Switch [High]: GAC Filter 3 [PV2330]	-	MFR	0	60	psig	[Vendor]	-	43 31 13.13	I-23-103
AE/AIT	23	30A	Filtrate Turbidity: GAC Filter 3 [PV2330]	0 - 100	-	0	100.0	NTU	[Vendor]	-	43 31 13.13	I-23-103
PI	23	30A	Outlet Pressure: GAC Filter 3 [PV2330]	0 - 60	-	0	60	psig	[Vendor]	-	43 31 13.13	I-23-103
ASH/AIC	24	10A	Leak Detection Switch [High]: Chlorine Room	0 - 10	MFR	0	10.0	ppm	[Vendor] Same AIC as ASH2410A	-	46 31 11	I-24-101
ASHH/AIC	24	10A	Leak Detection Switch [High High]: Chlorine Room	0 - 10	MFR	0	10.0	ppm	[Vendor] Same AIC as ASHH2410A	-	46 31 11	I-24-101
PSH	24	20A	Pressure Swith [High]: Chlortainer [T2410]	-	5	-	-	psig	[Vendor]	-	46 31 12	I-24-101
PI	24	20A	Pressure Indicator: Chlortainer [T2410]	FV - 100	-	-15	100	psig	[Vendor]	-	46 31 12	I-24-101
WE	24	30A	Weight: Chlorine Cylinder 1	MFR	-	0	MFR	lbs	[Vendor]	-	46 31 12	I-24-101
WE/WIT	24	40A	Weight: Chlorine Cylinder 2	MFR	-		MFR	lbs	[Vendor]	-	46 31 12	I-24-101
PI	24	21A	Suction Pressure: Chlorine Booster Pump 1 [P2421]	FV - 30	-	-15	30	psig	[Vendor]	-	46 31 11	I-24-102
PI	24	22A	Suction Pressure: Chlorine Booster Pump 2 [P2422]	FV - 30	-	-15	30	psig	[Vendor]	-	46 31 11	I-24-102
PI	24	23A	Suction Pressure: Chlorine Booster Pump 3 [P2423]	FV - 30	-	-15	30	psig	[Vendor]	-	46 31 11	I-24-102
PI	24	21B	Discharge Pressure: Chlorine Booster Pump 1 [P2421]	0 - 100	-	0	100.0	psig	[Vendor]	-	46 31 11	I-24-102
PI	24	22B	Discharge Pressure: Chlorine Booster Pump 2 [P2422]	0 - 100	-	0	100.0	psig	[Vendor]	-	46 31 11	I-24-102
PI	24	23B	Discharge Pressure: Chlorine Booster Pump 3 [P2423]	0 - 100	-	0	100.0	psig	[Vendor]	-	46 31 11	I-24-102
FI	24	31A	Chlorine Gas Flow: Chlorinator 1 [CHL2431]	0 - 25	-	0	25	PPD	[Vendor]	-	46 31 11	I-24-103

Tag Function Abb.	Tag Area Code	Tag Loop Identifier	Device Function	Operating Range	Setpoint	Min Calibration	Max Calibration	Units	Comments	Device Type	Specification Number	P&ID Number
PI	24	31A	Suction Pressure: Chlorine Injector 1 [INJ2431]	FV - 30	-	-15	30	psig	[Vendor]	-	46 31 11	I-24-103
PI	24	31B	Suction Pressure: Chlorine Injector 1 [INJ2431]	FV - 30	-	-15	30	psig	[Vendor]	-	46 31 11	I-24-103
PI	24	31C	Discharge Pressure: Chlorine Injector 1 [INJ2431]	0 - 100	-	0	100	psig	[Vendor]	-	46 31 11	I-24-103
PI	24	31D	Discharge Pressure: Chlorine Injector 1 [INJ2431]	0 - 100	-	0	100	psig	[Vendor]	-	46 31 11	I-24-103
FI	24	32A	Chlorine Gas Flow: Chlorinator 2 [CHL2432]	0 - 25	-	0	25	PPD	[Vendor]	-	46 31 11	I-24-103
PI	24	32A	Suction Pressure: Chlorine Injector 2 [INJ2432]	FV - 30	-	-15	30	psig	[Vendor]	-	46 31 11	I-24-103
PI	24	32B	Suction Pressure: Chlorine Injector 2 [INJ2432]	FV - 30	-	-15	30	psig	[Vendor]	-	46 31 11	I-24-103
PI	24	32C	Discharge Pressure: Chlorine Injector 2 [INJ2432]	0 - 100	-	0	100	psig	[Vendor]	-	46 31 11	I-24-103
PI	24	32D	Discharge Pressure: Chlorine Injector 2 [INJ2432]	0 - 100	-	0	100	psig	[Vendor]	-	46 31 11	I-24-103
WE/WIT	25	00A	Weight: Sodium Hydroxide Tote	0 - 1000	-	0	1000	lbs		WIT	46 61 33	I-25-101
PIT	25	10A	Discharge Pressure: Sodium Hydroxide Pump 1 [P2510]	0 - 100	-	0	90.00	psig		PGT	40 73 00	1-25-101
PIT	25	20A	Discharge Pressure: Sodium Hydroxide Pump 2 [P2520]	0-100	-	0	90.00	psig		PGT	40 73 00	1-25-101
PI	26	00A	Discharge Pressure: Coagulant Pump [P2610 + P2620]	0 - 100	-	0	100.0	psig	[Vendor]	-	46 61 33	1-26-101
WE	26	00A	Weight: Coagulant [T2600]	0 - 1000	-	0	1000.0	lbs	[Vendor]	-	46 61 33	1-26-101
LSL	26	00A	Level Switch [Low]: Coagulant [T2600]	-	MFR	-	-	lbs	[Vendor]	-	46 61 33	1-26-101
FE/FIT	27	00A	Discharge Flow: Plant Water Booster Pump [P2710+P2720]	10 - 38	-	0	40.0	gpm		FM	40 71 00	1-27-101
PIT	27	10A	Discharge Pressure: Plant Water Booster Pump [P2710+P2720]	35 - 60	-	0	70.0	psig		PGT	40 73 00	1-27-101
PI	27	10A	Discharge Pressure: Plant Water Booster Pump 1 [P2710]	MFR	-	0	MFR	psig	[Vendor]	-	43 21 20	1-27-101
PS	27	10A	Pressure Switch [High]: Plant Water Booster Pump 1 [P2710]	-	MFR	-	-	psig	[Vendor]	-	43 21 20	1-27-101
PI	27	20A	Discharge Pressure: Plant Water Booster Pump 2 [P2720]	MFR	-	0	MFR	psig	[Vendor]	-	43 21 20	1-27-101
PS	27	20A	Pressure Switch [High]: Plant Water Booster Pump 2 [P2720]	-	MFR	-	-	psig	[Vendor]	-	43 21 20	1-27-101
FE/FIT	30	00A	Outlet flow - FW Tank [T3010]	0 - 1000	-	-	1000	gpm		FM	40 71 00	I-30-101
PIT	30	10B	Water Level - FW Tank [T3010]	0 - 30	-	0.00	30.00	ft		LGH	40 72 00	I-30-101
ZS	30	20A	Intrusion Switch - FW Tank [T3010]	-	-	-	-	NA		-	26 09 16	I-30-101
ZS	30	20A	Intrusion Switch - FW Tank [T3010]	-	-	-	-	NA		-	26 09 16	I-30-101
AE/AIT	30	00A	pH: Treated Water	0 - 14	-	0	14.00	pH		AH	40 75 00	I-30-101
AE/AIT	30	00B	Residual Chlorine: Treated Water	0 - 2	-	0	2.00	ppm		CLR	40 75 00	I-30-101
AE/AIT	30	00C	pH: Finished Water	0 - 14	-	0	14.00	ppm		AH	40 75 00	I-30-101
AE/AIT	30	00D	Residual Chlorine: Finished Water	0 - 2	-	0	2.00	ppm		CLR	40 75 00	I-30-101
LE/LIT	40	10A	Water Level - Settling Basin Drying Bed 1	0 - 10	-	0	10.00	ft		LUT	40 72 00	I-40-101
LE/LIT	40	20A	Water Level - Settling Basin Drying Bed 2	0 - 10	-	0	10.00	ft		LUT	40 72 00	I-40-102
LE/LIT	40	30A	Water Level - Settling Basin Drying Bed 3	0 - 10	-	0	10.00	ft		LUT	40 72 00	I-40-103
LSHH	40	50A	Level Switch [High-High] - Solids Decant Vault	-	10	-	-	ft		LFS	40 72 00	1-40-104
LSH	40	50A	Level Switch [High] - Solids Decant Vault	-	9.5	-	-	ft		LFS	40 72 00	1-40-104
LSM	40	50A	Level Switch [Medium] - Solids Decant Vault	-	10	-	-	ft		LFS	40 72 00	1-40-104
LSL	40	50A	Level Switch [Low] - Solids Decant Vault	-	9.5	-	-	ft		LFS	40 72 00	1-40-104
TSH	40	51A	Temperature Switch [High] - Decant Pump 1 [P4051]	-	MFR	-	-	°F	[Vendor]	-	43 23 80.12	1-40-104
MSH	40	51A	Moisture Switch [High] - Decant Pump 1 [P4051]	-	MFR	-	-	%	[Vendor]	-	43 23 80.12	1-40-104
TSH	40	52A	Temperature Switch [High] - Decant Pump 2 [P4052]	-	MFR	-	-	°F	[Vendor]	-	43 23 80.12	1-40-104
MSH	40	52A	Moisture Switch [High] - Decant Pump 2 [P4052]	-	MFR	-	-	%	[Vendor]	-	43 23 80.12	1-40-104
LE/LIT	50	10A	Water Level - Chemical Backwash Solids Drying Bed 1	0 - 4	-	0	4.00	ft		LUT	40 72 00	1-50-101
LE/LIT	50	20A	Water Level - Chemical Backwash Solids Drying Bed 2	0 - 4	-	0	4.00	ft		LUT	40 72 00	1-50-101
LE/LIT	70	10A	Water Level - Plate Settler	0 - 10	-	0	10.00	ft		LUT	40 72 00	1-70-101
LSHH	70	10A	Level Switch [High High] - Plate Settler	-	10	-	-	ft		LFS	40 72 00	1-70-101
ZS	70	10A	Intrusion Switch - Plate Settler - Hatch 1	-	-	-	-	NA		-	26 09 16	1-70-101
ZS	70	10B	Intrusion Switch - Plate Settler - Hatch 2	-	-	-	-	NA		-	26 09 16	1-70-101
TSH	70	11A	Temperature Switch [High] - Plate Settler Pump 1 [P7011]	-	MFR	-	-	°F	[Vendor]	-	43 23 80.12	1-70-101
MSH	70	11A	Moisture Switch [High] - Plate Settler Pump 1 [P7011]	-	MFR	-	-	%	[Vendor]	-	43 23 80.12	1-70-101
TSH	70	12A	Temperature Switch [High] - Plate Settler Pump 2 [P7012]	-	MFR	-	-	°F	[Vendor]	-	43 23 80.12	1-70-101
MSH	70	12A	Moisture Switch [High] - Plate Settler Pump 2 [P7012]	-	MFR	-	-	%	[Vendor]	-	43 23 80.12	1-70-101
LE/LIT	70	20A	Water Level - Settled Backwash Solids	0 - 10	-	0	10.00	ft		LUT	40 72 00	1-70-102
LSHH	70	20A	Level Switch [High High] - Settled Backwash Solids	-	10	-	-	ft		LFS	40 72 00	1-70-102
ZS	70	20A	Intrusion Switch - Settled Backwash Solids - Hatch 1	-	-	-	-	NA		-	26 09 16	1-70-102
ZS	70	20B	Intrusion Switch - Settled Backwash Solids - Hatch 2	-	-	-	-	NA		-	26 09 16	1-70-102
TSH	70	21A	Temperature Switch [High] - Settled Backwash Solids Pump 1 [P7021]	-	MFR	-	-	°F	[Vendor]	-	43 23 80.12	1-70-102
MSH	70	21A	Moisture Switch [High] - Settled Backwash Solids Pump 1 [P7021]	-	MFR	-	-	%	[Vendor]	-	43 23 80.12	1-70-102
TSH	70	22A	Temperature Switch [High] - Settled Backwash Solids Pump 2 [P7022]	-	MFR	-	-	°F	[Vendor]	-	43 23 80.12	1-70-102
MSH	70	22A	Moisture Switch [High] - Settled Backwash Solids Pump 2 [P7022]	-	MFR	-	-	%	[Vendor]	-	43 23 80.12	1-70-102
LE/LIT	70	30A	Water Level - Recycled Backwash Water	0 - 10	-	0	10.00	ft		LUT	40 72 00	1-70-103
LSHH	70	30A	Level Switch [High High] - Recycled Backwash Water	-	10	-	-	ft		LFS	40 72 00	1-70-103
ZS	70	30A	Intrusion Switch - Recycled Backwash Water - Hatch 1	-	-	-	-	NA		-	26 09 16	1-70-103
ZS	70	30B	Intrusion Switch - Recycled Backwash Water - Hatch 2	-	-	-	-	NA		-	26 09 16	1-70-103
TSH	70	31A	Temperature Switch [High] - Recycled Backwash Water Pump 1 [P7031]	-	MFR	-	-	°F	[Vendor]	-	43 23 80.12	1-70-103
MSH	70	31A	Moisture Switch [High] - Recycled Backwash Water Pump 1 [P7031]	-	MFR	-	-	%	[Vendor]	-	43 23 80.12	1-70-103
TSH	70	32A	Temperature Switch [High] - Recycled Backwash Water Pump 2 [P7032]	-	MFR	-	-	°F	[Vendor]	-	43 23 80.12	1-70-103

Tag Function Abb.	Tag Area Code	Tag Loop Identifier	Device Function	Operating Range	Setpoint	Min Calibration	Max Calibration	Units	Comments	Device Type	Specification Number	P&ID Number
MSH	70	32A	Moisture Switch [High] - Recycled Backwash Water Pump 2 [P7032]	-	MFR	-	-	%	[Vendor]	-	43 23 80.12	1-70-103
ZS	70	40A	Intrusion Switch - Solids Valve and Meter Vault - Hatch	-	-	-	-	NA		-	26 09 16	1-70-104
FE/FIT	70	10A	Flow: Solids Valve and Meter Vault - Plate Settler Tank	0-200	-	0	300.0	gpm	NEMA 6P/IP67	FM	40 71 00	1-70-104
FE/FIT	70	10B	Flow: Solids Valve and Meter Vault - Solids Equalization Tank	0-200	-	0	300.0	gpm	NEMA 6P/IP67	FM	40 71 00	1-70-104
FE/FIT	70	20A	Flow: Solids Valve and Meter Vault - Solids Drying Bed 1	0-200	-	0	300.0	gpm	NEMA 6P/IP67	FM	40 71 00	1-70-104
FE/FIT	70	30A	Flow: Solids Valve and Meter Vault - Raw Water Tank	0-200	-	0	300.0	gpm	NEMA 6P/IP67	FM	40 71 00	1-70-104
FE/FIT	70	30B	Flow: Solids Valve and Meter Vault - Settled Backwash Water Tank	0-200	-	0	300.0	gpm	NEMA 6P/IP67	FM	40 71 00	1-70-104

Tag Function Abb.	Tag Loop Identifier	Device Function	Operating Range	Setpoint	Min Calibration	Max Calibration	Units	Comments	Device Type	Specification Number
FE/FIT	-	Discharge Flow Meter	Mfr	NA	0	Mfr	gpm		FM2	40 71 00
FI/FY	-	Discharge Flow Indicator	NA	NA	0	Mfr	gpm	Match range of FIT	FI	40 71 00
PI	-	Suction Pressure	Mfr	NA	0	Mfr	psig		-	43 23 92
PI	-	Discharge Pressure	Mfr	NA	0	Mfr	psig		-	43 23 92

SECTION 40 41 13.14

ELECTRIC HEAT TRACE DRAIN DE-ICING

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies electric heat trace and control for roof drain and downspout de-icing.

B. Refer to the Drawings for drains requiring De-Icing.

1.02 QUALITY ASSURANCE

A. Manufacturer's Responsibilities:
   1. Contractor shall ensure that complete equipment systems be the direct product of one manufacturer and supplier who shall assume all responsibility for:
      a. Manufacturing
      b. Start-up
      c. Warranty.
   2. Manufacturer shall have at least 5 years of experience in the production of heat tracing systems.

B. Reference Standards:
   1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
UL515	Electrical Resistance Heat Tracing for Commercial Applications
IEEE 515	The Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Commercial Applications

1.03 SUBMITTALS

A. Procedures: Section 01 33 00

B. Action Submittal Items:
   1. Manufacturer's product literature for heat trace and heat trace controllers.
   2. Connection kits and accessories.
   3. Shop drawings showing locations of power taps, thermostats, end seals, circuit layout and cable length.

4. Maximum amperage rating for each heat trace circuit.
5. Sizing calculations for each run of heat trace, showing startup current values.
6. Manufacturer's warranty information for the following components, but not limited to:
   a. Wiring
   b. Control devices.
7. Operation and Maintenance manual information in accordance with Section 01 78 23.

1.04 DRAIN DE-ICING DESIGN

A. Drain De-Icing systems shall consist of Electric Heat Trace as specified in this section.

B. Drain De-Icing shall be installed and secured in accordance with manufacturers recommendations.

PART 2 PRODUCTS

2.01 FABRICATION

A. Manufacturers: All heat trace components shall be produced by the same manufacturer:
   1. Thermon Manufacturing Company.
   2. Raychem/nVent Thermal Management.
   3. Or equal.

B. General:
   1. Heat trace shall consist of self-limiting, parallel circuit construction with a continuous inner core of conductive material between two copper bus wires.
   2. The resistance and heating capacity of the heating material shall vary in response to ambient temperature changes.
   3. Heat trace for use with Type A, thermostat controllers shall operate using single phase, 60 Hz power, 120 VAC unless specified otherwise in this Section.
   4. Heat trace shall be provided with copper braid and polyolefin jacket.
   5. Heat trace for use with Type A thermostat controllers shall be protected by a ground-fault equipment protection (GFEP; 30 mA) circuit breaker.

C. Conform to Manufacturer's recommendations for maximum thermal rating and maximum amperage per heat trace controller where these recommendations are less than those specified in this Section.
   1. Heat trace shall have a maximum thermal rating of 12 watts per foot in ice or snow.

2.02 CONTROLS

A. General:
   1. Each heat trace circuit shall be controlled by a thermostat. Thermostat shall be provided in a NEMA 4x, watertight enclosure.

B. Type A: Type A thermostat shall control by sensing ambient temperature with the following characteristics:
   1. Electrical rating: Min 22A at 120 VAC
   2. Type: Dry Contact
   3. Setpoint temperature range: 15 to 140 degrees F
   4. Calibration tolerance: 2 degrees F
   5. Sensor material: Stainless steel
   6. Housing exposure temperature: -40 to 140 degrees F
   7. Maintain Temperature: 40 degrees F
   8. Dry contact for remote monitoring of alarm condition

C. Power connection junction box shall include a green LED light to indicate power is supplied to the heating circuit.

PART 3 EXECUTION

3.01 INSTALLATION

A. Fasten heat trace to drain with downspout hangers for mechanical protection and strain relief as recommended by the manufacturer.

END OF SECTION

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SECTION 40 42 00

INSULATION FOR EXPOSED PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes thermal insulation for exposed piping, related equipment, and appurtenant surfaces.

1.02 RELATED SECTIONS

A. Section 40 05 02 – Detailed Piping Specification Sheets

B. Section 40 50 07 – Pipe Supports and Hangers

C. Section 40 05 07.13 – Seismic Restraints for Piping

D. Section 40 05 45 – Piping System Identification

E. Section 40 41 13.14 – Electric Heat Tracer Tape

1.03 REFERENCES

A. This Section incorporates by reference the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of a listed document, the requirements of this Section prevail.

B. ASTM B209 – Aluminum and Aluminum-Alloy Sheet and Plate

C. ASTM C533 – Calcium Silicate Block and Pipe Thermal Insulation

D. ASTM C534 – Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form

E. ASTM C547 – Standard Specification for Mineral Fiber Pipe Insulation

F. ASTM C553 – Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications

G. ASTM C592 – Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation

H. ASTM C610 – Expanded Perlite Block and Pipe Thermal Insulation

I. ASTM C795 – Thermal Insulation for Use in Contact with Austenitic Stainless Steel

J. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials

K. ASTM E96 – Water Vapor Transmission of Materials

L. FEDSPEC L-P-535E -- Plastic Sheet (Sheeting) “Plastic Strip” Poly (Vinyl Chloride) and Poly (Vinyl Chloride-Vinyl Acetate), Rigid

M. ASTM C1676 – Microporous Thermal Insulation

N. ASTM C1729 – Aluminum Jacketing and Insulation

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:

B. Low-temperature range: Operating temperature range of -100 to +100 degrees F.

C. Medium-temperature range: Operating temperature range of 100 to 800 degrees F.

D. High-temperature range: Operating temperature range of 800 to 1200 degrees F.

E. Very-high-temperature range: Operating temperature range of 1200 to 1800 degrees F.

F. Jacket: Protective outer layer placed over insulation on straight runs of pipe.

G. Cover: Protective outer layer placed over insulation on valves, strainers, expansion joints, flanges, pipe fittings, couplings, and equipment.

H. Exposed: All area exposures specified in Section 01 61 45 other than buried, submerged, or encased/embedded.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Sequencing: After installation of insulation for pipe and equipment is complete, provide identification as described in Section 40 05 45.

1.06 SUBMITTALS

A. Procedures: Section 01 33 00

B. Action Submittals:
   1. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations.
   2. Manufacturer’s descriptive literature, including insulation and jacket thickness, heat transfer coefficient, and methods of installation.
   3. Certification of jacket ratings for water vapor transmission, puncture and stiffness as specified.
   4. ASTM C795 certification, for insulation applied to stainless steel pipe.

C. Informational Submittals:
   1. Samples of each insulation material type and thickness along with typical jackets and covers for pipe, fittings, valves and appurtenances. Provide a full diameter segment for each insulation sample, 6 inches in length.

D. Closeout Submittals:
   1. Warranty Documentation

1.07 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00

B. Deliver insulation, jackets and covering to site using methods which do not damage the materials.

C. Deliver insulation materials to site clearly identified as to type and temperature rating.

D. Store insulation materials on site as recommended by the manufacturer to prevent damage or and weathering.

E. Replace damaged or weathered insulation materials with new materials.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Candidate manufacturers and models are listed below. The manufacturer's standard product may require modification to conform to specified requirements.

B. Cellular Elastomeric Tube
   1. Armacell, AP Armaflex
   2. K-Flex, Insul-Tube
   3. Approved Equal

C. Mineral Wool
   1. Roxul, ProRox PS960
   2. Johns Manville, Min-Wool 1200
   3. Owens Corning, Thermafiber Pro Section WR
   4. Approved Equal

D. Fiberglass
   1. Johns Manville, Micro-Lok HP
   2. Owens Corning, FIBERGLAS
   3. Approved Equal

E. Calcium Silicate
   1. Johns Manville, Thermo-1200
   2. Approved Equal

F. Cellular Elastomeric Flexible Blanket
   1. Armacell, AP Armaflex
   2. K-flex, Insul-Sheet
   3. Approved Equal

G. Fiberglass Flexible Blanket
   1. Amatex, Amamat
   2. Lewco, E Glass
   3. Approved Equal

H. Mineral Wool Flexible Blanket
   1. Johns Manville, Min-Wool 1200 Pipe and Tank Wrap
   2. Roxul, Enerwrap MA 960
   3. Approved Equal

I. Silica or Ceramic Fiber Flexible Blanket (Very High Temperature Range)
   1. Morgan Thermal Ceramics, Superwool 607 Blanket AC2
   2. Unifrax, Fiberfrax
   3. Harbison Walker, Inswool-HP
   4. Hitco, Refrasil
   5. Approved Equal

J. Expanded Perlite
   1. Johns Manville, Sproule WR-1200
   2. Approved Equal

K. Thin Flexible Blanket
   1. Johns Manville, InsulThin HT
   2. Approved Equal

2.02 INSULATION SERVICE CONDITIONS

A. Insulation Service Types
   1. Insulation service types define the function of the insulation. The extent and location of insulation application is based on the function of the insulation. This Section specifies the following insulation service types: Condensate Control, Personnel Protection, Freeze Protection, and Energy Conservation. Insulation Service Types and insulation materials for piping systems are specified in Piping System Schedules.
   2. Condensate Control is specified for piping that is to be insulated for condensate control. Where Condensate Control is specified for a piping service, furnish insulation for all pipe and pipeline appurtenances with a line size of ½-inch and larger that are located in Indoor Dry or Indoor Wet areas.
   3. Personnel Protection is specified for piping that is to be insulated to protect personnel from injury related to exposure to temperatures above 140 degrees F or below 32 degrees F. Where Personnel Protection is specified for a piping service in the Piping System Schedules, furnish insulation for all pipe and pipeline appurtenances where all of the following conditions are present:

a. Piping is connected to the discharge or exhaust of equipment (includes equipment and pipeline appurtenances).
b. Equipment, pipe, or pipeline appurtenances are located within 0.0 to 8.0 feet above a floor, stair, landing, or other type of walkway accessible by plant staff, or within 4.0 feet of a guardrail or ladder cage. Pipe, pipeline appurtenances, joints, flanges, valves, and equipment in vaults, utilidors, and other spaces that are not designed for pedestrian access by plant staff are not insulated for Personnel Protection.

4. Freeze Protection is specified for piping that is to be insulated and heat traced to protect against freezing the contents of the pipe. Where Freeze Protection is specified for a piping service in the Piping System Schedules, furnish insulation for all piping to be freeze protected by electric heat trace tape as specified in Section 40 41 13.13. Coordinate electric heat trace tape installation with specified insulation requirements for freeze protection to provide freeze protection for piping as specified in Section 40 41 13.13.
5. Energy Conservation is specified for piping that is to be insulated to conserve energy. Where Energy Conservation is specified for a piping service in the Piping System Schedules, furnish insulation for all pipe and pipeline appurtenances for the entire portion of the piping system that is exposed.

2.03 MATERIALS

A. Recommended Insulation Applications:

Operating Range Name	Operating Temperature Range °F	Insulation Material	Cover/Jacket Material
Low	-100 to +100	Unicellular Elastomeric Thermal Mineral Wool Fiberglass	Aluminum PVC
Medium	100 to 750	Mineral Wool Fiberglass Expanded Perlite	Aluminum
High	750 to 1200	Calcium Silicate Mineral Wool Expanded Perlite	Aluminum
Very High	1200 to 1800	Ceramic Fiber	Non-combustible Fabric Cover

B. General:
1. Provide materials that are new and undamaged.
2. Match specified pipe insulation and jacket/cover material for insulation on valves, strainers, fittings, expansion joints, flanges, and other pipe couplings. Furnish flexible blanket insulation and soft covers if insulation on valves, strainers, fittings, expansion joints, flanges, and other pipe couplings is not available in the same materials as the specified pipe insulation and jacket/cover.
3. Provide rigid insulation and shields at pipe supports for insulated pipe. Match specified jacket/cover material for pipe shields at pipe supports.
4. Provide insulating and sealing materials, including cements, coverings, etc., that do not contain asbestos, mercury, or lead.

5. When covering stainless steel pipe, pipeline appurtenances, or equipment, use insulation that complies with ASTM C795.
6. Flame spread classification for insulation materials is not to exceed 25 when tested in accordance with ASTM E84.
7. Use fibrous loose fill insulation for joint filler around insulated expansion joints.

C. Fiberglass Flexible Blanket: Flexible fiberglass blanket insulation designed for continuous 1200 degree F service. 8.0 pounds per cubic foot density, minimum. Long fiber, random orientation, needled.

D. Mineral Wool Flexible Blanket: Flexible mineral wool blanket insulation designed for continuous 1200 degree F service.

E. Silica or Ceramic Fiber Flexible Blanket: High purity alumina and silica non-asbestos white ceramic fiber insulation designed for continuous 1800 degree F service.

F. Aluminum Insulation Jackets/Covers
1. Aluminum jackets and covers constructed of smooth finish aluminum sheet conforming to ASTM B209, alloy 3003, or 3105 temper H14, with integral vapor barrier.
2. Pipe Insulation Jacket thickness per ASTM C1729, as follows.

Outer Insulation Diameter (inches)	Aluminum jacket thickness, rigid insulation (inch)	Aluminum jacket thickness, flexible and semi-rigid insulation (inch)
≤ 8	0.016	0.016
8 thru 11	0.016	0.020
11 thru 24	0.016	0.024
24 thru 36	0.020	0.032
≥ 36	0.024	0.040

3. Furnish 0.030 inch, minimum thickness, for aluminum insulation covers at valves, strainers, fittings, expansion joints, flanges, and other pipe couplings.
4. Aluminum or stainless steel sheet metal screws.
5. Jackets secured with 0.020 inch thick by ¾ inch wide Type 304 stainless steel expansion bands.
6. Flashing includes aluminum caps, sealant and reinforcing.
7. Provide aluminum caps, 20 gauge. Cut to completely cover the insulation.
8. Provide sealants as recommended by the insulation manufacturer.
9. Provide wire mesh reinforcement or nylon fabric reinforcement in sealant at jacket and cover joints. Reinforcement material as recommended by the insulation manufacturer.

G. PVC Insulation Jackets and Covers
1. One piece PVC covers and jackets. 20 mil thickness, minimum.
2. Pre-molded polyvinylchloride conforming to FEDSPEC L-P-535E, Composition A, Type II, Grade E4.

H. Non-combustible Fabric Cover
   1. Custom fit reusable covers. Sewn or stapled covers encapsulating insulation with stainless steel staples/hog rings. Close fit to the piping, pipeline appurtenance, or equipment housing.
   2. Fabricated from 32 ounce TFE-coated or silicone coated fiberglass cloth with concealed/interior stitching, staples or hog rings (not exposed). For flexible blanket insulation installed for High-Temperature and Very High-Temperature Range applications, eliminate non-combustible fabric material on hot face of covers and provide stainless steel wire mesh on hot face of covers.
   3. Fabric rated for continuous exposure to the temperature range of the insulation (Low, Medium, High, or Very High Temperature Range).
   4. Secured in place with stainless steel lacing hooks, lock washers, and lacing wire.
   5. Stitched or quilted to prevent consolidation, shifting, or settlement of insulation when subjected to vibration.

PART 3 EXECUTION

3.01 PREPARATION

A. Apply insulation over clean, dry surfaces.

B. Ensure insulation is dry before and during application.

C. Do not apply protective pipe coatings to outside surface of insulation jackets or covers.

D. Do not paint PVC, aluminum, or fabric covers.

E. Do not install insulation or jackets/covers before piping and equipment has been tested and approved. Thermal shields at pipe hangers and supports may be installed prior to testing.

F. Provide thermal pipe hanger shields at pipe supports and bracing as specified on the Drawings, Details, Section 40 05 07 and Section 40 05 07.13.

3.02 INSTALLATION

A. General
   1. Where insulation thickness exceeds 3 inches, double layer insulation must be provided. Install double layer insulation with staggered section joints.
   2. Supply insulated thermal pipe hanger shields and install during pipe support installation. Where insulated thermal pipe hanger shields are used, apply the following to all butt joints:
      a. For pipe insulation with a medium, high, or very high Operating Temperature Range, apply 3 inch wide vapor barrier tape or band over the butt joints.
      b. For pipe with a low Operating Temperature Range, apply a wet coat of vapor barrier lap cement on all butt joints and seal the joints with a minimum 3 inch wide vapor barrier tape or band.

B. Protect insulation and jackets from crushing, denting, and similar damage during construction. Do not penetrate or otherwise damage vapor barriers. Remove any insulation, jacket, and vapor barriers damaged during construction and install new material.

C. Provide flashing at joints between insulation jackets, between insulation jackets and insulation covers, and at endcaps. Provide flashing around flange sets, pipe couplings/connections, and joint fittings. Allow adequate clearance between insulation rings, jackets and the joint connection for the removal and reinstallation of hardware during inspection and maintenance activities.

D. Piping Insulation
   1. Install uninterrupted (continuous) insulation as indicated for the specified Insulation Service Conditions (Condensation Control, Energy Conservation, Personnel Protection, or Freeze Protection). Insulate over pipe and all in-line devices such as valves, fittings, flanges, couplings, strainers and other piping appurtenances. Butt insulation firmly together and provide jacket laps and joint strips with lap adhesive. Provide a minimum of 2 inches of lap length. Install jackets with their seams located on the underside of pipe.
   2. Covers overlap the adjoining pipe insulation and jackets.
   3. Install covers with their seams located on the underside of valves, fittings, flanges, couplings, strainers and other piping appurtenances.
   4. Low Operating Temperature Range
      a. Seal off ends of pipe insulation with a vapor barrier coating.
      b. Seal covers at edges with vapor barrier adhesive. Secure the ends of covers with vinyl tape. Overlap the jacket and the cover at least one inch with vinyl tape. Do not penetrate vapor barrier.
   5. Medium, High, and Very High Operating Temperature Range
      a. Seal ends of insulation with end joint strips and use waterproof adhesive to hold them in place.
      b. Mechanically secure covers using corrosion-resistant tacks pushed into the overlapping throat joint.
   6. Insulation for Outdoor Piping
      a. Where insulated pipe emerges from soil, concrete or asphalt terminate insulation for exposed pipe at the interface with insulation for buried pipe. If buried pipe is not insulated, extend insulation to within an inch above the finished surface. Do not push insulation into contact with soil, finished concrete, or asphalt surface.
      b. Provide heat tracing as specified in Section 40 41 13.13. Install insulation over heat tracing according to the specifications of the heat trace tape and insulation manufacturers.

E. Mechanical Equipment Insulation
   1. Unless otherwise specified in this Section, fit insulation to the contours of equipment and secure it with 1/2 by 0.015 inch stainless steel bands. Weld pins or stick clips with washers may be used for flat surfaces and spaced a maximum 18 inches apart. Stagger joints and fill voids with insulating cement.
   2. Overlap ends of blanket segments to prevent gaps and voids when the piping and equipment are heated.

3. Secure blankets snugly under nuts and bolt heads to assure complete coverage during operation and to prevent vibration-induced gaps or voids.
4. Secure blankets in strict accordance with the manufacturer's instructions.

F. Flashing
1. Provide flashing at jacket penetrations and terminations. Provide clearance for flashing between insulation system and piping supports.
2. Form aluminum caps to fit over the adjacent jacketing and to completely cover coated insulation. Hold cap in place with a jacket strap.

END OF SECTION

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SECTION 40 61 13

PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies general requirements applicable to Sections 40 06 70 through 40 75 00 of these specifications for the process control, instrumentation, communication, network, and signal systems. This work is for the Lake Powell Intake Pump Station (Intake PS), the LeChee Water Treatment Plant (WTP), and the LeChee Pump Station (PS) No. 3. This work will be referenced as the Process and Instrumentation Control System (PICS) to be provided by a single Systems Integrator (SI) meeting the qualifications section of this specification.

B. System overview. Detailed requirements are in individual related specification sections.
   1. Intake PS.
      a. Provide power and control infrastructure, equipment, and telemetry for two pump trains.
      b. Test and verify operation of Intake PS to provide raw water to the WTP below.
      c. Test and verify telemetry of control and SCADA signals to/from Intake PS and WTP via the LeChee PS No. 3, refer to Drawing I-00-301.
   2. Provide LeChee WTP.
      a. Provide treatment plant, equipment, and telemetry.
      b. Test and verify operation of WTP to provide treated water to the PS below.
      c. Test and verify telemetry of control and SCADA signals to/from Intake PS and WTP via the LeChee PS No. 3, refer to Drawing I-00-301.
   3. LeChee PS No. 3 to provide water to the existing LeChee Tanks below.
      a. Provide equipment and telemetry.
      b. Test and verify operation of PS to control existing LeChee Tanks level below.
      c. Provide fiber optic cable from PS to intercept existing cable per Section 27 13 23.23.
      d. Provide SCADA and test.
   4. LeChee Tanks exist. This site shall communicate with LeChee Pump Station No. 3 via radio telemetry.
      a. Provide modifications to the existing telemetry.
      b. Test telemetry to LeChee PS No. 3.
      c. Schedule and coordinate work to minimize water system control outages. Refer to Sections 01 11 00 and 01 12 16.
   5. Provide telemetry units per details from Navajo Area Indian Health Service/NTUA – Technical Provisions 4.0 for Tank Control Panel.
   6. Provide testing per Sections 01 45 20 and 40 61 21.
   7. Field Instrumentation.

8. Process Control Hardware:
    a. Field controllers use programmable logic controllers (PLC).
    b. Control panels.
    c. Modification of existing control panel at LeChee Tanks.
9. Process Control Software, Programming, and Integration:
    a. Programming shall be provided as follows, coordinate work, programmers, and provide testing. Refer to meetings in Section 40 68 03.
    b. Intake PS:
        1) Telemetry PLC and Touchscreen: By the Systems Integrator (SI) due to complexity and warranty requirements of the tandem pump operation. Coordinate PLC and touchscreen graphic programs per Navajo Tribal Utility Authority (NTUA) requirements.
    c. LeChee WTP:
        1) Telemetry PLC and Touchscreen: By the NTUA.
        2) Treatment PLC and Touchscreen: By the SI.
        3) Membrane LCP and touchscreen: By the Manufacturer as specified in Section 43 31 13.13,
        4) GAC LCP and touchscreen: By the Manufacturer as specified in Section 46 61 33,
        5) Plant Operator Workstation Operator Interface Software: By the SI.
    d. LeChee PS No. 3:
        1) Telemetry PLC and Touchscreen: By the NTUA.
    e. Existing LeChee Tanks:
        1) Existing Telemetry PLC and touchscreen program modifications: By the NTUA.
    f. SCADA programming will be provided by the NTUA.
        1) Mapping of data shall be provided by the SI from the WTP Treatment PLC and Membrane LCP to the WTP Telemetry PLC for SCADA monitoring.
    g. Provide one-day on-site and/or video coordination meeting with NTUA to review PLC communication registers, analog value ranges, and other PLC to SCADA communication details per NTUA requirements. Provide agenda and list of data signals in advance for NTUA review. Provide meeting minutes of decisions. Meeting shall be attended by:
        1) Contractor.
        2) SI Programmer.
        3) Membrane Manufacturer Programmer.
10. Communications and Networking:
    a. Wireless telemetry communications systems.
    b. Interface to existing Owner fiber optic network
    c. Hardwired fiber-optic and copper communications systems.

1.02 RELATED SECTIONS:

A. The requirements of this section are applicable to work specified in Sections 40 61 21 through 40 75 00 of these specifications.

B. Section 40 06 70 – Schedules for Instrumentation of Process Systems.

1.03 REFERENCES

A. Reference Standards:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.
   2. Unless otherwise specified, references to documents mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids).
   3. If referenced documents have been discontinued by the issuing organization, references to those documents mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.
   4. Where document dates are given in the following listing, references to those documents mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
IEEE 100	Standard Dictionary of Electrical and Electronics Terms
ISA 5.4	Instrument Loop Diagrams
ISA 20	Specification Forms for Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
ISA 51.1	Process Instrumentation Terminology
ISA TR20.00.01	Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations
NEMA ICS 1	General Standards for Industrial Control and Systems

1.04 DEFINITIONS

A. Abbreviations:
   1. dBm: decibel-milliwatts
   2. OIT: operator interface terminal
   3. PICS: Process and Instrumentation Control System
   4. PLC: programmable logic controller
   5. SCADA: supervisory control and data acquisition
   6. SI: Systems Integrator

B. Definitions General:
   1. General: Definitions of terminology related to Instrumentation and Industrial Electronic Systems used in the specifications as defined in IEEE 100, ISA 51.1, and NEMA ICS 1.
   2. Data sheets: Data sheets refer to ISA 20 or ISA TR20.00.01, as referenced within ISA-20-1981 specification.
   3. Two-wire transmitter: A transducer that derives operating power supply from the signal transmission circuit and requires no separate power supply connections. A two-wire transmitter produces a 4- to 20-milliampere current regulated signal in a series circuit with a 24-volt direct current (VDC) driving potential and a maximum circuit resistance of 600 ohms.
   4. Four-wire transmitter: A transducer that derives operating power from separate power supply connections. A four-wire transmitter produces a 4- to 20-milliampere current regulated signal in a series circuit with a maximum circuit resistance of 600 ohms. Four-wire transmitters typically require 120-volt alternating current (VAC) or 24VDC input power supply.
   5. Galvanic isolation: An electrical node having no direct current path to another electrical node. Galvanic isolation refers to a device with electrical inputs and/or outputs that are isolated from ground, the device case, the process fluid, and separate power supply terminals. Inputs and/or outputs may be externally grounded without affecting the characteristics of the devices or providing a path for circulation of ground currents.
   6. Panel: An instrument support system that may be a flat surface, partial enclosure, or complete enclosure for instruments and other devices used in process control systems including consoles, cabinets, and racks. Panels provide mechanical protection, electrical isolation, and environmental protection from dust, dirt, moisture, and chemical contaminants that may be present in the atmosphere.
   7. Systems Integrator: A firm engaged in the business of detailed control system design and engineering, instrumentation component purchase, system and panel assembly, control device programming, and implementing of the specified process control and industrial automation systems.

C. Definitions—Signal Types:
   1. Analog, low level: Signal with full output level of 100 millivolts or less including thermocouples and resistance temperature detectors.
   2. Analog, high level: Signals with full output level greater than 100 millivolts but less than 30 volts, including 4 to 20 mA transmission.
   3. Digital code: Coded information from the output of an analog-to-digital converter or digital transmission terminal.
   4. Discrete control or events: Dry contact closures and signals monitored by solid-state equipment, relays, or control circuits.
   5. Discrete control or events, low voltage: Dry contact closures and signals monitored by solid-state equipment, relays, or control circuits operating at less than 30 volts and 250 milliamperes.
   6. Modulated signals: Signals from modems or low-level audio signals. Normal signal level: plus 4 dBm to minus 22 dBm. Frequency range is 300 to 10,000 hertz.

7. Pulse frequency: Counting pulses emitted from speed or flow transmitters.
8. Radio frequency (RF) signals: Continuous wave alternating current signals with fundamental frequency greater in a range of 310 kilohertz to 300 gigahertz.

D. Definition—Drawing Types:
   1. Elementary or schematic diagram:
      a. Use graphic symbols to indicate the electrical connections and functions of a specific circuit arrangement. The schematic diagram facilitates tracing of the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.
      b. Indicate connections to internal and external components connected to the panel. Note which devices are external to the panel.
      c. Depicted in ladder logic format.
      d. Indicates contact arrangement of internal and external devices such that circuits are complete and match equipment furnished.
      e. Indicates equipment designations/tag numbers to match contract drawings and Process and Instrumentation Diagrams (P&IDs).
   2. Network block diagram:
      a. A diagram of the overall control system, containing annotated boxes showing the primary network components (controllers, hubs, routers, switches, computers, displays).
      b. Include annotated interconnecting lines showing the system communication media and communication protocols.
      c. Indicate manufacturer and model of the primary network components and software.
      d. Indicates functions performed by each device (e.g., Historical Data Server, Field controller, Database Server, Operator workstation, etc.)
   3. Connection diagram:
      a. Purpose is to show wiring requirements between internal panel components.
      b. Show components of a control panel in an arrangement similar to the actual panel layout.
      c. Indicate internal wiring between components.
      d. Show terminal blocks used for internal wiring and field wiring, with identification as such.
      e. Indicate insulation color code, signal polarities, wire numbers, and terminal block numbers.
   4. Arrangement, layout, or outline drawings:
      a. Show the physical space and mounting requirements of a piece of equipment.
      b. Indicate ventilation requirements and space provided for connections or the location to which connections are to be made.
      c. Indicate clearance requirements for ventilation and access.
      d. Show the dimensioned external and interior control panel views with components and Bill of Material.

5. Loop diagrams:
    a. Prepared per ISA 5.4 – Loop Diagrams using the sample Loop Diagrams.
    b. Show device element wiring of the system. Indicate device terminations, with terminal numbers.
    c. Show circuits for hardwired device interlocks.
    d. Show circuit cable and wire cable numbers, signal polarities, and terminal block numbers.
    e. Show connection to power supplies. Include alternating current (AC) and direct current (DC) power supplies and circuit information for instruments furnished under this Contract.
    f. Indicate controller or I/O card address/node, rack, slot, and point wiring terminals.
    g. Show power supplies for signal loops. Indicate in which panel components reside and power originates with circuit numbering/name. Where new/modified loops connect to an existing power supply, show the existing power supply name, location, and circuit.
    h. Indicate surge protection type, manufacturer, and model number (i.e., types include floating ground reference or grounded reference).
    i. Show new and modified terminal blocks with numbering in new and existing panels.
    j. Indicate signal loop grounding terminations.
    k. Indicate loop numbers, wire numbers, and cable numbers used in field wiring and panel wiring.
    l. Indicate field element being controlled or monitored (i.e., normally open contact from relay CR17, or FIT 365).

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
    1. Coordinate the process and instrumentation control system for proper operation with related equipment and systems specified in other Divisions.
    2. Integrate equipment in conformance with the drawings, specifications, and recommendations of the equipment manufacturer and the related processes equipment manufacturers.
    3. Obtain manufacturer's technical information for items of equipment not provided with, but connected to, the control system. Provide the necessary coordination and components for correct signal interfaces between equipment and the control system.
    4. Coordinate interface requirements and schedule with other project subcontractors and equipment suppliers.
    5. Present to the Construction Manager conflicts between the plans, specifications, manufacturer/vendor drawings, and installation instructions, etc. for resolution before proceeding.

B. Pre-submittal conference: Not used.

1.06 SUBMITTALS

A. Procedures: Section 01 33 00.

1. Where specified, separate submittals shall be provided for each of the Intake PS, LeChee WTP, and LeChee PS No. 3. In the event that combined submittals are permitted, information shall be separated by each facility. Failure to separate product literature by facility shall be sufficient cause for rejection of the entire submittal with no further consideration.

B. Action Submittals – General Requirements:

1. This article indicates general requirements applicable to all PICS submittals. Additional information to be submitted with each section will be listed under Action Submittals or Closeout Submittals in this and each related section.
    a. Submit all information for sections covered by a submittal as a complete package in one submittal. Partial submittals of a section from multiple vendors showing contractor's division of equipment, labor, or portions of the work are not acceptable.
    b. Include a table of contents in each submittal divided by specification section and content of each section such as drawings and components. Clearly indicate the article or paragraph to which each table of content item applies.
    c. Related sections indicate additional detail for each submittal.
    d. Bookmark PDF submittals to match the table of contents of each submittal. Submitted information is to conform to the following:
    e. Shop Drawings: Prepare drawings in AutoCAD with borders and title blocks identifying the project, system, revisions to the drawing, and type of drawing. Include a date and description for each revision of a drawing including the date and description of the revisions. Drawing prints shall be 11" by 17" with a minimum lettering size of 1/8".
    f. Product Literature: Provide manufacturer's specifications, data sheets, and catalog literature for the equipment and components that clearly and unambiguously show what is being provided and that it meets the requirements specified. Indicate provided and available options, materials of construction, environmental characteristics, electrical characteristics, and connection requirements. Include only applicable information.
    g. Conformance with Contract Documents:
        1) Provide a copy of sections applicable to the submittal group with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
        2) Check-marks (✓) denote full compliance with a paragraph as a whole. Underline deviations and denote them with a number in the margin to the right of the identified paragraph. Paragraph portions not underlined signify specification compliance. Include a detailed, written justification for each deviation. Show conformance with all paragraphs in a section. Failure to include a copy of the marked-up specification sections and justification(s) for requested deviations is cause for rejection of the entire submittal with no further consideration.

3) Mark a copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, mark the drawing or drawings "no changes required." Failure to include copies of the relevant drawings with the submittal is cause for rejection of the entire submittal with no further review. Contract drawings would include the following:
   a) Network system block diagrams.
   b) Control single-line diagrams.
   c) Process and instrumentation diagrams.
   d) Equipment installation details.
4) Show conformance across suppliers and vendors in one submittal. Partial submittals from multiple vendors showing contractor's division of labor or portions of the work are not acceptable.
5) Provide a detailed written request and explanation for each deviation. Failure to include a copy of the marked-up specification sections and drawings, along with justification(s) for requested deviations to the contract requirements, with the submittal, is cause for rejection of the entire submittal with no further consideration.

C. Action Submittals – Quality Assurance.
   1. Submit within 30 days of contract Notice to Proceed:
      a. Systems Integrator qualifications per paragraph 1.07, Quality Assurance.

D. Action Submittals – Field Instruments:
   1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements.

      A check mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.

      The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications.

      Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. Submittal requirements of Section 40 71 00.
   3. Submittal requirements of Section 40 72 00.
   4. Submittal requirements of Section 40 73 00.
   5. Submittal requirements of Section 40 74 00.
   6. Submittal requirements of Section 40 75 00.

E. Closeout Submittals - General Requirements.
   1. Procedures: Section 01 78 23.
   2. Provide record drawing prints of drawings and schedules following project startup, but prior to acceptance of the work, showing the final constructed state of the process instrumentation and control systems.
   3. Include the following in each operation and maintenance manual:
      a. Final reviewed submittals, including revised as-built drawings.
      b. Manufacturer's operation and maintenance instructions, edited for this project.
      c. Written record of menu configuration, jumpers, switch settings, and other configurable parameters for each instrument.
      d. Final network equipment software configurations.
      e. Provide one listing of spare parts that is divided by specification section.

F. Closeout Submittals - Programming.
   1. Final application software configurations, in the software native format. Include a comprehensive report print-out from each controller. Provide files on compact disc (CD) or NTUA preferred media.

G. Closeout Submittals – Record Drawings.
   1. Record Documents specified in Section 01 78 39 and Part 3.

1.07 QUALITY ASSURANCE

A. All work covered by Sections 40 61 13 through 40 75 00 shall be the responsibility of a single Systems Integrator as defined within this article.

B. The instrumentation and control system functions are shown on the drawings and specified in subsequent sections of Division 40. The Systems Integrator drawings and integration practices shall be as defined in IEEE 100, ISA 51.1, and NEMA ICS 1.

C. Demonstrate the overall system performance to the Owner for acceptance.

D. Systems Integrator qualifications:
   1. The following Systems Integrators are pre-qualified to perform the work specified in Division 40 without the need to provide Evidence of Experience:
      a. Enterprise Automation, Irvine, CA.
   2. Evidence of Experience—Company specializing in the products and work of this section and related sections:
      a. Minimum of 10 years of documented experience with the equipment specified as well as overall systems responsibility for systems of similar size and complexity.
      b. Experience in performing three similar successful projects (equipment type, software type, Systems Integrator responsibilities, complexity, and dollar value of work performed by Systems Integrator) in the last 5 years. At least one project currently in progress or completed within the last 2 years.
      c. End-user satisfaction of projects in the past 3 to 5 years based on end-user interviews by the Owner or Engineer. Submit project descriptions of projects completed within the past 5 years with contact names, addresses, and telephone numbers from the project Owner, General Contractor, and Principal Design Firm.

d. Panel fabrication and staging facilities adequate to provide services for this project. Demonstrate by including the following:
   1) Minimum 10,000 square feet of dedicated space for panel fabrication and testing.
   2) Panel shop shall be UL 508 recognized to produce panels to UL 508 and UL 698 standards and labeling.
e. Financial resources available and projected for successful completion of this project. Submit financial data for Systems Integrator division when subsidiary to a parent corporation. Include 2 years of financial data:
   1) Financial statement.
   2) Balance sheet.
   3) Dun & Bradstreet Report.

E. Systems Integrator Personnel Qualifications: Provide qualified personnel to complete the work specified for this project. Demonstrate by including the following:
   1. Organization chart and resumes for proposed project personnel showing experience for the proposed roles on this project.
   2. Training and certification information. Completion of the following training courses or appropriate portions thereof or possession of the following certifications included with the Systems Integrator's personnel experience requirements described above:
      a. Project manager: Control System Engineer (CSE) registration, Professional Engineer (PE) registration, or Project Management Professional (PMP) certification.
      b. Systems engineer: Control System Engineer (CSE) registration, Professional Engineer (PE) registration, or completion of the relevant core courses in the Engineering Skills Training program as certified by ISA.
      c. Not used.
      d. Field instrument technician: Certified Control Systems Technician (CCST) registration or completion of the relevant core courses in the Technical Skills Training program as certified by ISA.
   3. Certified per Section 40 68 13.

1.08 ENVIRONMENTAL CONDITIONS

A. Ambient conditions: Per Sections 01 11 80 and 26 05 00.

B. Corrosive locations: Per Section 26 05 00.

C. Hazardous (Classified) areas: None.

D. Seismic:
   1. Brace equipment and supports per Section 01 73 24 and Structural Drawing S-00-001.

PART 2 PRODUCTS

2.01 EQUIPMENT/MATERIALS

A. General requirements:
   1. New.
   2. Free from defects.
   3. Rated for the installed environment.

B. Similar control system components, instrument, instrument accessory, and devices used throughout the work shall be manufactured by one firm, where possible.

C. The components, modules, devices, and control system equipment shall be recognized industrial-quality products. Recognized commercial- or office-grade products are prohibited.

2.02 ENCLOSURES

A. Table A specifies the instrument and control panel enclosure material and minimum NEMA rating for the location and application where not identified in other specification sections.

TABLE A

Location	Enclosure Material and NEMA Rating
Indoor: architecturally finished area	NEMA 12: mild steel
Indoor: electrical room	NEMA 12: mild steel
Indoor: Process or Corrosive areas	NEMA 4X: 316 stainless steel
Outdoor: Non-Corrosive areas	NEMA 3R or 4: Mild steel
Corrosive area (hypochlorite)	NEMA 4X: Non-metallic

2.03 NAMEPLATES

A. Provide nameplates for field-mounted instrument, analyzer, or equipment covered by this section with the following requirements:
   1. Include the equipment or instrument loop title and the instrument or equipment tag number, where nameplate engraving is not specified or shown.
   2. Machine engraved black phenolic with white letters or stamped stainless steel with 5/32-inch-high lettering, as minimum, unless otherwise specified or shown.

B. Nameplate wording may be changed without additional cost or time, if changes are made prior to commencement of engraving.

C. Attach nameplates to support hardware with a minimum of two self-tapping type 316 stainless steel screws in a readily visible location so the nameplate will remain to identify the service when the device is removed. Attach field instrument nameplates with braided stainless-steel straps where not stand-mounted.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Install equipment in locations that are accessible for operation and maintenance services.
   2. Installation, calibration, settings, and testing procedures are specified in Section 40 61 13, Section 40 06 70, and subsequent sections of Divisions 26 and 40.

B. Field Equipment:
   1. Install equipment between 48 inches and 60 inches above the floor or permanent work platform. Equipment shall be mounted to avoid shock or vibration that may impair operation. Equipment shall be mounted for unobstructed access and walkways. Equipment support systems shall not be attached to handrails, process piping or mechanical equipment.
   2. Space instruments and cabinets from concrete walls by 5/8 inch with framing channel between instrument or cabinet and wall. Add supports to block wall to avoid damage to the wall.
   3. Design support systems, including panels, in accordance with Section 01 73 24 to prevent deformation greater than 1/8 inch in any direction under the attached equipment load and under an external load of 200 pounds.
   4. In wet or outdoor areas, make conduit penetrations into instrument housing or panels through the bottom (preferred) or side of enclosures to minimize water entry from around or from inside of conduits. Provide conduit hubs for connections and waterproof mastic for moisture sealant.
   5. Provide nameplates for field-mounted equipment. Attach nameplates in a readily visible location, but such that if the field device is replaced, the nameplate will remain to identify the service.

3.02 INTEGRATION WITH OTHER SYSTEMS:

A. Integrate with Membrane system specified in Section 46 61 33.

3.03 FIELD QUALITY CONTROL

A. Delivery Inspection:
   1. Notify the Owner's Representative upon arrival of material or equipment to be incorporated into the work. Remove protective covers or otherwise provide access in order that the Owner's Representative may inspect such items.

B. Inspection and Installed Tests:
   1. Refer to Section 40 61 21.

3.04 RECORD DOCUMENTS

A. Contract Documents shall be maintained and annotated by the Contractor during construction, including the Record Drawings specified in Section 01 78 39.

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SECTION 40 61 21

PROCESS CONTROL SYSTEM TESTING

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies testing requirements applicable to Sections 40 06 70 through 40 75 00 of these specifications for the process control, instrumentation, communication, network, and signal systems. This work will be referenced as the Process and Instrumentation Control System (PICS) to be provided by a PICS Testing Manager meeting the Qualifications section of this specification. Section includes:
   1. Testing documentation.
   2. Testing organization and sequencing.
   3. Factory Acceptance Testing (FAT).
   4. Performance testing.
   5. Loop testing.
   6. Functional testing.
   7. Operational testing.

B. Related sections:
   1. Section 40 06 70 – Schedules for Instrumentation of Process Systems
   2. Section 40 61 13 – Process Control System General Provisions
   3. Section 40 61 96 – Process Control Descriptions

1.02 QUALITY ASSURANCE

A. Definitions:
   1. The term “instrumentation” covers field and panel instruments, analyzers, primary sensing elements, transmitters, power supplies, and monitoring devices.

B. Reference Standards:
   1. Refer to Section 40 61 13.

C. Appoint a startup engineer or qualified specialist as PICS Testing Manager to manage, coordinate, and supervise the testing work.

D. The quality assurance program includes:
   1. Definition of process areas and systems, with testing executed on an area-by-area basis, based on the P&ID drawings.
   2. Testing for each process area executed in sequential tasks.
   3. Regularly updated testing status tracking by process area, system, and task.
   4. Regularly updated separate testing documentation for each process system.

E. PICS Testing Manager Qualifications:
   1. The PICS Testing Manager shall have at least 5 years of total experience, or experience on at least five separate projects, in managing the testing and startup of similar electrical and instrumentation control systems.

F. Testing Technician Qualifications:
   1. Employ technicians who are qualified by completion and certification from training courses offered by the International Society of Automation (ISA), the instrumentation and analyzer manufacturer's training courses, or technician training courses at a recognized trade school that specializes in instrumentation calibration.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate testing with Section 01 45 20.
   2. Provide notice to the Construction Manager prior to conducting a test.
   3. Provide a detailed step-by-step test procedure, between 60 and 70 days before the commencement of testing activity, complete with forms for the recording of test results, testing equipment used, and a place for identification of the individuals performing and witnessing the test.
   4. Provide detail assistance to the Contractor in generating Section 01 99 00 Form 01 45 20-A, customized for this project. Submit detailed form prior to testing per the requirements of Section 01 45 20.
   5. Equipment and System Performance and Operational Testing: Section 01 45 20 specifies testing of the mechanical, electrical, instrumentation, and heating, ventilation and air conditioning (HVAC) systems. Coordinate, manage, and supervise the work with the quality assurance program including:
      a. Testing plan with the sequence for the test work.
      b. Calibration program for instruments and analyzers.
      c. Documentation program that records tests results.
      d. Performance testing program systems.

1.04 SUBMITTALS

A. Procedures: Section 01 33 00.

B. Provide separate submittals for each of the Intake PS, LeChee WTP, and the LeChee PS No. 3 for the following:

C. Action Submittals – Testing Plan:
   1. Quality Assurance submittal:
      a. PICS Testing Manager Qualifications.
      b. Testing Technician Qualifications.
      c. Proposed process area and process system organization.

2. Testing Plan:
    a. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Owners Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
    b. A marked copy of specification Section 01 45 20.
    c. Submit detailed testing plan and proposed testing documentation after review of the Quality Assurance submittal showing conformance with Part 2 of this specification. Obtain approved submittal prior to testing. Separate submittals may be provided for each process area or test group for the WTP:
        1) Control descriptions.
        2) Input/Output (I/O) interface.
        3) Testing status spreadsheets.
        4) Test procedures per Part 3.
        5) Proposed test forms per this section, detailed for each test for this project.
        6) List of Certified Factory Calibration Reports for flow and temperature transmitters.

D. Action Submittals – FAT:
    1. Schedule and location.
    2. Procedures and test forms.

E. Closeout Submittals – Final Tests:
    1. Final Test Report assembled in a three-ring binder and submitted at the completion of the inspection and testing activities for a process area.
        a. Label the binder cover and spine to identify the project name and process area. Include in the test report the applicable test procedures for the process area and the completed inspection and test report forms associated with the equipment and systems of that area.
        b. Organize test results by equipment item or system with individual, labeled tab dividers to identify each. The responsible testing entity is to acknowledge system deficiencies and noncompliant test results identified in the final test report as corrected.
        c. Documentation of network data communication nodes for network-type instruments, devices, and variable-frequency drives.
        d. Test equipment and test equipment calibration date.

e. Completed test forms per Part 3.
f. Certified factory calibration reports for flow and temperature transmitters.
g. Record of radio modem readings per Part 3.
h. Performance test results.
i. Loop test results.
j. Functional test results.
k. Operational test results.

PART 2 PRODUCTS

2.01 GENERAL

A. Test forms: Conform to the requirements of Reference Forms 40 61 13-A through 40 61 13-M included in Section 01 99 90. Develop additional or detailed forms as necessary to suit complex instrumentation. Use terms on test forms that comply with ISA S51.1.

B. Project Labeling:
1. The items specifying project labeling herein include the following as a minimum: Owner's name, facility name, project name, and Client project number.

2.02 TESTING DOCUMENTATION

A. Documentation Records:
1. Develop a record-keeping system to document progress and completion for each task in each process area or system. Coordinate overall organization of areas and systems with overall testing required by Section 01 45 20, Equipment and System Performance and Operational Testing.
2. Always keep documentation current and available for inspection on site in a location designated by the Construction Manager:
a. PICS Testing Manager's qualifications, project startup, and testing history, including resume per paragraph 1.02E PICS Testing Manager.
b. List of names of Contractor's and System Integrator's personnel associated with final construction and testing, and normal and emergency contact telephone numbers
c. Testing Status spreadsheet with breakdown for each process area and process system, with percentage complete on each testing sequence task.
d. Testing status specific to pre-loop test and loop testing status spreadsheet to include the I/O list organized by area and system and loop number. Percent complete of the PICS system will be based on percentage of I/O points tested.
e. Test Report Volumes.

B. Test Report Volumes:
1. Develop and maintain testing documentation for each process area or system in separate volumes. Always keep each volume current and available for inspection on site in a location designated by the Construction Manager. Include the following as a minimum:
a. Three-ring binder with front cover and spine labeled: "Testing Documentation for (applicable) Process Area / Process System" including project labeling.

b. Table of Contents with same labeling as the volume cover with tabs for each section:
c. Section 1: Control Description
d. Section 2: I/O Interface
e. Section 3: Instrument Index
f. Section 4: Test Procedures and Forms
g. Section 5: Certified Factory Calibration Reports
h. Section 6: Test Report

C. Control Description:
1. Provide a control description outlining operation for each process area's system. The Control Description Specification Section 40 61 96 may be used as a basis.

D. I/O Interface:
1. Provide I/O spreadsheets for each process area's system. Spreadsheets are to include the following for each I/O point:
a. Signal number/tag.
b. Annotation description that may be logically abbreviated and that is subject to approval.
c. Complete physical I/O channel designation and addressing or communication I/O register designation.
d. True/false status designations for digital I/O.
e. Process range; engineering units and multipliers; and raw signal range count for analog I/O.
f. Signals: Fixed point and scaled at the controller with minimum four significant implied digits of scaling; e.g., 0 to 1,400 at controller for a pH range of 0 to 14 at operator interface.
g. Provide operator interface scaling to display decimal digits required.
h. Indicate pass/fail for each point for both pre-loop test and loop tests.
i. Indicate date of tests and comment for failed points.

E. Instrument Index:
1. Provide a detailed Instrument Index. The Instrument Index from Section 40 06 70 may be used as a basis. Indicate actual calibration ranges, set points, and deadbands.

F. Field Test Procedure Documentation:
1. Organize and assemble test procedures for each analog and discrete loop in the process control system in separate volumes for each process area or test group. Organize by I/O point. Submit final test records in electronic form by scanning and converting the records and files to Adobe PDF format, to preserve actual signatures and signoffs.
2. Include a detailed, step-by-step description of the required test procedure, panel and terminal block numbers for points of measurement, input test values, expected resultant values, test equipment required, process setup requirements, and safety precautions.

3. Include test report forms for each loop, including forms for wiring, piping, and individual component tests, with the test procedure documentation. Record the actual test results on these forms and assemble them into final test reports.
4. Preprint and populate information in the test report forms to the extent possible prior to commencing testing.
5. Include on the test report forms:
    a. Project name.
    b. Process area associated with the equipment under test.
    c. Instrument loop description.
    d. Instrument loop identification number.
    e. Instrument nameplate data.
    f. Instrument setup and configuration parameters.
    g. Time and date of test.
    h. Inspection checklist and results.
    i. Reference to applicable test procedure.
    j. Expected and actual test results for each test point in the loop including programmable controller data table or register values.
    k. Test equipment used.
    l. Space for remarks regarding test procedure or results, observations, etc.
    m. Name, date, and signature of testing personnel.
    n. Test witness's name and signature.

2.03 SOURCE QUALITY CONTROL

A. Factory Acceptance Test (FAT):
    1. Provide a FAT with the test and subsequent retests witnessed by the Construction Manager and Owner.
    2. Load software and configuration for control system panels, controllers, network components, operator interfaces, servers, and the programming and graphic configuration application at the control system equipment supplier's factory prior to the FAT.
    3. Inspect equipment, panel instruments, panels, or cabinets with factory testing performed.
    4. Provide written notice to the Construction Manager 30 working days before the commencement of the FAT activity and include:
        a. Schedule for the FAT.
        b. Location of the FAT.
        c. Testing equipment used.
        d. Detailed test procedure with forms for the recording of test results.
        e. Sign-off spaces for the individuals performing and witnessing the tests.
    5. Network and interwire equipment and panels as applicable.
    6. Operate and check out equipment prior to the FAT. Submit certification indicating that the panels are ready for the FAT.

7. Include the following. Provide documentation to include Section 01 99 00 Form 40 61 21-L:
    a. Visual inspection of equipment, instruments, control panels, and graphic displays.
    b. Validation of each input loop and output loop by simulated signals for analog inputs and by shorting discrete inputs.
    c. Validation includes:
        1) Monitoring state changes on operator interface screens based on the inputs state change.
        2) Observation of online controller programming application software with the associated outputs state change.
        3) Outputs triggered by operator interface software devices (pushbuttons, sliders, manually entered values, etc.)
        4) Calibration and operation of instruments on or in the control panels.
    d. Repair of loops that do not pass validation.
    e. Retest of the FAT at no additional cost.

PART 3 EXECUTION

3.01 GENERAL

A. General Requirements:
1. Provide the labor, tools, material, power, and services necessary to provide the process instrumentation and control system inspection and testing specified herein.
2. Inspect materials, equipment, and construction included under this specification in accordance with this section and subsequent sections of this division. Perform testing in accordance with this and subsequent sections of this division.
3. Have a certified instrument technician qualified to calibrate the instrumentation calibrate and set up field instruments and analyzers.

B. Test Equipment and Materials:
1. Provide test equipment to conduct the specified tests that simulate inputs and read outputs with a rated accuracy at the point of measurement at least three times greater than the component under test.
2. Provide a calibration sticker on test instruments showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required. Include certified calibration reports traceable to the National Institute of Standards and Technology with the final test report.
3. Provide a documenting calibration system to conduct process instrumentation calibration activities that consist of a documenting process calibrator and an instrumentation data management software system that captures the calibration results and electronically document instrument data, date of calibration, calibration procedures, and as-found and as-left instrument calibration data.
4. Not used.
5. Provide buffer solutions and reference fluids for tests of analytical equipment.
6. Not used.
7. Not used.

C. Performance Deviation Tolerances:
   1. Tolerances are specified in individual sections. Where tolerances are not specified, refer to the manufacturer's published performance specifications.
   2. Calculate overall accuracy requirements for loops consisting of two or more components, by the root-summation-square (RSS) of the component accuracy specifications. Calculate and record tolerances for each required calibration point on the associated test report form.

D. Witnessing:
   1. The Construction Manager reserves the right to observe factory and field instrumentation testing and calibration procedures. Notify the Construction Manager prior to testing, as specified herein.

3.02 TESTING SEQUENCE

A. Perform tests for each area or system in the following sequence:
   1. Performance testing
   2. Loop testing
   3. Functional testing
   4. Operational testing

B. Group equipment and I/O based on the relationship of the equipment to operate safely as specified, including full automatic and manual control and monitoring through the control system. Equipment and I/O in a given area or system shall pass testing prior to proceeding to the next set of tests in the sequence above.

3.03 PERFORMANCE TESTING

A. Perform tests in the order below.

B. Wiring Tests:
   1. Verify that electrical power and signal cable ring-out and resistance testing has been performed as specified in Sections 26 05 00 and 26 08 00. Conduct wiring tests after cables have been properly terminated, tagged, and inspected.
      a. Power and Control: Section 26 08 00.
      b. Signal: Section 01 99 00 Form 40 61 13-A.

C. Network Cable Inspection and Testing:
   1. Have a qualified independent network testing service test standardized networks. The following types of cabling and networks shall be tested and certified by the independent industrial network testing firm:
      a. Ethernet system cabling.
      b. Other networks provided as a part of a packaged monitoring or control system.
   2. Test and verify control and instrumentation bus cabling using the standards that apply to the specific cable and bus type as follows:
      a. Ethernet Category 5E and Category 6: per TIA/EIA-568B standards.

D. Not Used.

E. Not Used.

F. Telemetry Communications:
   1. Perform the following, witnessed by the Owner and Programmer. Section 01 99 00 Form 40 61 21-M:
   2. Examine antenna/cable assembly for quality of workmanship. The cable connection to the antenna shall be sealed with tape, then covered with vulcanizing rubber and sealed with tape.
   3. Provide laptop PC for radio-modem configuration. After complete radio and transmission system installation, connect specified cable from radio to PC. Perform the following:
      a. Perform VSWR test. Record reflected power reading and submit as Product Data. The system will not be accepted with a reflected power of > 0.2 watts at 1 watt rated output. Test to performed with radio timeout timer and frequency hopper functions temporarily disabled.
      b. Record radio system address.
      c. Verify radio antenna alignment to the other specified radio location.
      d. Record RSSI readings after antenna alignment is complete. Communications are not to exceed -100 dBm.
      e. Verify unit is set for master mode if tank site, remote mode for wells. If configured for master, check for long polling (Modbus messaging).
      f. Verify radio setting Buff = On.
      g. Verify radio to PLC communication settings:
         1) Baud Rate = 12009600
         2) Data Bits = 8
         3) Parity = Even
         4) Stop Bits = 1
   4. Transmission line or antenna related fault or trouble conditions shall be investigated and resolved to the satisfaction of the Owner. Replace damaged transmission line or related components, lightning protectors, poles, towers, or connectors that were installed improperly. Re-align antennas as required for maximum signal strength.
   5. Inventory all panel parts and appropriate documentation.

G. Instrumentation Calibration:
   1. Calibrate instruments and final elements in accordance with the manufacturer's recommended procedures and tested in accordance with the Contractor's test procedure.
   2. Complete and document instruments and component inspections to the satisfaction of the Construction Manager prior to individual component calibration and testing.
   3. Calibrate analog instrument at 0, 10, 50, 90, and 100 percent of the specified full-scale range. Adjust each signal sensing trip and process sensing switch to the required setting. Verify instrument readout matches loop signal. Test data recorded on test forms as specified herein.
   4. Test and adjust final element alignment to verify that each final element operates smoothly over the full range in response to the specified process control signals.

5. Enter test data on the applicable test forms at the time of testing: set alarm trips, control trips, and switches to initial values specified in Section 40 06 70 Instrument Index at this time. Check final elements for range, deadband, and speed of response.
6. Have any component repaired or replaced by the manufacturer where the component fails to meet the required tolerances. Repeat the specified tests until the component is within tolerance.
7. Install a calibration sticker on each instrument following successful calibration that indicates the date of calibration, the name of the testing company, and personnel who calibrated the instrument.
8. Section 01 99 00 Test forms 40 61 13-D through I.
9. Certified Test Reports: Field test and inspection activities include verification of instrument parameter setup, verification of instrument zero, and performance at three operating points within the instrument range. Return each instrument that fails to demonstrate proper performance for recalibration or replaced as agreed depending on the impact to the project as determined by the Construction Manager.
    a. Where instrument field calibration is not feasible, certified factory calibration reports may be submitted that include the name and address of the laboratory that conducts the calibration testing. Certified factory test reports may be submitted for the following instrument types in lieu of field calibration:

Factory Calibration Instrument List

Instrument Identification	Instrument Section	Description
FM	40 71 00	Magnetic flow metering system
TRE/TMP	40 74 00	Resistance temperature element, insertion type

H. Pre-Loop Testing:
1. Test every I/O point from the field device to the termination on the I/O card in the panel.
2. Perform tests with loop wiring complete and terminated for each point being tested between initial field device and I/O termination point.
3. For each discrete I/O point, verify and document contact status value for both the opened and closed positions of the contact.
4. For analog points, verify analog value matches local display. Confirm calibration at 0, 25, 75, and 100 percent of value.

3.04 LOOP TESTING

A. Provide a request to perform loop testing at least 2 weeks prior to the requested loop test date. Include the following with the request:
1. Area/system for which request is being made.
2. Written certification that performance testing has been completed, documented, and passed for the area/system for which loop testing is being requested.
3. Submittal numbers that define the tests and data points for the I/O to be tested. Provide updates to the I/O list or instrument calibration as an outcome of the performance testing.

B. Commence loop testing after the performance testing has been completed and documented to the satisfaction of the Construction Manager.

C. Test each instrument loop as an integrated system. Check operation from field instruments to transmitter to receiving components to the vendor panel or the Plant Control System Operator Interface Station. Inject test signals at the process impulse line connection where the measuring technique permits, and otherwise at the most primary signal access point.

D. For each discrete I/O point, verify and document field contact status value for both the opened and closed position of the contact.

E. For analog points, verify that analog value matches local display. Confirm calibration at 0, 25, 75, and 100 percent of value.

F. Where loops are interfaced to a controller, verify the controller I/O assignment and operation of the input/output system and processor. Inspect the data table or register in the PLC memory to verify proper operation.

G. If the output control or monitoring device fails to indicate properly, make corrections to the loop circuitry or device. Repeat the test until devices and instruments operate as required.

H. Correct loop circuitry and repeat the test until the instruments operate properly.

I. Test Section 01 99 00 Form 40 61 13-J.

3.05 FUNCTIONAL TESTING

A. Process Control Strategy/Functional Testing:
   1. Commence control strategy testing after loop testing has been completed and documented to the satisfaction of the Construction Manager.
   2. Control strategy testing, performed by the Contractor and Programmer, consists of installing and debugging the PLC control logic program, verifying the interface points between the controller I/O cards and field devices and equipment, and exercising the control strategies. Perform control strategy testing on one PLC at a time.
   3. Provide qualified personnel to immediately correct deficiencies in the work that may be encountered during control strategy testing. Failure of the Contractor to provide such personnel in a timely manner may prolong the time allotted to complete control strategy testing.

B. Control System Closed-Loop Testing:
   1. Commence closed-loop commissioning after the control strategy testing has been successfully completed and documented to the satisfaction of the Construction Manager.
   2. Demonstrate stable operation of each loop under operating conditions. Adjust loop tuning parameters as part of the test.
   3. Tuning parameters: gain (or proportional band), integral time constant, and derivative time constant for each control loop, adjusted to provide 1/4-amplitude damping, unless otherwise specified.

4. Provide the loop response to a step disturbance for each loop. Provide two graphs for cascaded control loops, one showing the secondary loop response with its set point in manual, and the second showing overall loop response.
5. Not used.
6. Not used.
7. Where a loop is controlled under the direction of a PLC, the Programmer shall perform the necessary adjustment of loop tuning parameters and set points, record the loop response, adjusting final elements, and ensuring total integrated loop performance as specified.

C. Functional Checkout:
1. Conduct to verify the operation of discrete and hardwired control devices, refer to Section 01 45 20. Exercise the operable devices and energize the control circuit. Operate control element, alarm device, and interlocks to verify that the specified action occurs.

3.06 OPERATIONAL TESTING

A. Perform the Operational Tests after component and subsystem tests have been completed. Perform the test of the completed system in full operation and demonstrate that functional requirements of this specification have been met. Demonstrate the following:
1. Each component of the system operates correctly with other components of the system.
2. Analog control loops operate in a stable manner.
3. Hard-wired and software equipment interlocks perform correctly.
4. Process control sequences perform correctly.
5. Application program performs monitoring and control functions correctly.
6. Supervisory control and data acquisition (SCADA) operator interface graphics represent the monitoring and control functions correctly.

END OF SECTION

SECTION 40 61 96

PROCESS CONTROL DESCRIPTIONS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies control by the following:
   1. Standard Interlocks that are referred to by various processes are in Paragraph 3.01.
   2. Standard Control Strategies that are referred to by various processes, or are required regardless of being otherwise specified are in Paragraph 3.02.
   3. Telemetry System processes for the Intake PS to the WTP Raw Water Tank is specified in Paragraph 3.10.
   4. Telemetry System processes for the Finished Water Reservoir to the LeChee PS No. 3 is specified in Paragraph 3.54.
   5. WTP processes are specified in Paragraphs 3.10 through 3.62.
   6. WTP MBR processes are specified in Paragraph 3.20 through 3.31.

B. Control strategies for packaged equipment are further specified in the respective equipment specifications:
   1. WTP GAC.
   2. The MBR system is basically described herein, subject to change by the Manufacturer.
   3. LeChee PS No. 3.

C. These control strategies are not intended to apportion work or responsibility for work among subcontractors, suppliers and manufacturers, but are offered as a guide for programming, testing, and commissioning. They describe how the system is to operate, and do not necessarily include every component required to make the system function.

D. Control strategies describe sequential and interlocking control functions, analog control functions, color-graphic video display SCADA Computers and Operator Interfaces and alarm and event logging. All control functions shall be programmed in the control system PLC controller, the Operator Interfaces and SCADA computers shall perform supervisory functions only.

E. The Contractor shall provide the labor and equipment to test the specified control strategies per Section 40 61 21.

F. Programming: Refer to Section 40 61 13.

PART 2 NOT USED

PART 3 EXECUTION

3.01 STANDARD INTERLOCKS

A. Interlocks:

1. Interlocks (I) shut down and prevent equipment from operating. These are defined here and referenced in Control Strategies below.
2. Hardwired interlocks are effective whether the PLC system is in operation or not, and in HAND and AUTO modes unless noted.
3. Software interlocks are provided by the PLC and are usually only effective when the equipment is operating in AUTO mode unless noted. For this reason, software interlocks are not always in effect for equipment or personnel protection. Software interlocks unique to each process system are defined starting in paragraph 3.10 below.

I1 – MOTOR PROTECTION

Equipment motor protection includes motor starter overload and/or Variable Frequency Drive (VFD) or Reduced Voltage Solid State Starter (RVSS) fault, hardwired only. Manual reset required at the starter, VFD, or RVSS.

I2 – HIGH DISCHARGE PRESSURE

Equipment protection from pressure switch, hardwired only. Time delayed; no time delay for positive displacement pumps. Manual reset required at the starter, VFD, or RVSS.

I3 – HIGH MOTOR TEMPERATURE

Equipment motor protection from temperature switch or temperature sensors and switching relay, hardwired only. Manual reset required at the starter, VFD, or RVSS.

I4 – LOW DISCHARGE FLOW

Equipment protection from flow switch, hardwired only. Time delayed. Manual reset required at the starter, VFD, or RVSS.

I9 – EMERGENCY STOP

Personnel command from maintained pushbutton or pull-cord, hardwired only. Manual reset required at the pushbutton or pull-cord.

I10 – HIGH MOISTURE

Equipment motor protection from moisture sensor and switching relay, hardwired only. Manual reset required at the starter, VFD, or RVSS.

I11 – LOW FLUSH WATER FLOW

Equipment protection from flow switch, hardwired only. Time delayed. Manual reset required at the starter, VFD, or RVSS.

I12 – LOW FLUSH WATER PRESSURE

Equipment protection from pressure switch, hardwired only. Time delayed. Manual reset required at the starter, VFD, or RVSS.

I13 – DIAPHRAGM LEAK

Equipment protection from conductivity sensor and switching relay, hardwired only. Manual reset required at the starter or VFD.

I17 – LOW OIL LEVEL

Equipment protection from level switch, hardwired only. Time delayed. Manual reset required at the starter, VFD, or RVSS.

I19 – LOW SUCTION PRESSUR

Equipment protection from pressure switch, hardwired only. Time delayed; no time delay for positive displacement pumps. Self-resetting.

3.02 STANDARD CONTROL STRATEGIES

A. Control Strategies:

1. Standard Control Strategies (CS) define common equipment operations performed by the PLC software.
2. Hardwired control strategies are effective whether the PLC system is in operation or not. These are specified in the respective equipment specifications.
3. Control strategies unique to each process system are defined starting in paragraph 3.10 below.
4. Standard Control Strategies denoted with an asterisk (*) shall be provided as applicable, unless noted otherwise.

CS1 - EQUIPMENT RUN TIME TOTALIZATION

Equipment run time totalization will be calculated and maintained by the PLC based on equipment run status. Totalize in hours from 0 to 9999. Provide unless physical run time hour meters are specified.

SCADA: Display total in hours.

CS2 - FLOW TOTALIZATION

Flow totalization will be calculated and maintained by the PLC whenever flow signals exceeds 2-1/2 % of full-scale value and analog signal has not failed (refer to CS10). Totalize in gallons times 1,000 (kGal) or gallons times 1,000,000 (MGal) as shown on the P&ID. Totalize from 0 to 9999.

SCADA: Display total in kGal or MGal as shown on P&ID.

CS3 - PROCESS ALARM(S), SELF-RESETTING

Process alarms as shown on the P&ID will be determined and maintained by the PLC:

1) Low-Low Alarm: Point value is equal to or less than a predetermined alarm value.
2) Low Alarm: Point value is equal to or less than a predetermined alarm value.
3) High Alarm: Point value is equal to or greater than a predetermined alarm value.
4) High-High Alarm: Point value is equal to or greater than a predetermined alarm value.

An analog point which is in alarm status will not be changed to normal status until the point value changes by the predetermined deadband value for the point, initial setting of 5% of full scale range. Alarm setpoints are provided in paragraph 40 06 70-3.03 instrument index.

SCADA: Display alarms. Display active and cleared-but-unacknowledged alarms in the alarm summary.

CS7 - PROCESS ALARM(S), MANUAL RESET REQUIRED

Process alarms as shown on the P&ID will be determined and maintained by the PLC:

1) Low-Low Alarm: Point value is equal to or less than a predetermined alarm value. This is typically an equipment shutdown alarm.
2) Low Alarm: Point value is equal to or less than a predetermined alarm value.
3) High Alarm: Point value is equal to or greater than a predetermined alarm value.

b. High-High Alarm: Point value is equal to or greater than a predetermined alarm value. This is typically an equipment shutdown alarm.

An analog point which is in alarm status will not be changed to normal status until reset by the SCADA Operator and the point value changes by the predetermined deadband value for the point, initial setting of 5% of full-scale range. PLC alarm setpoints are provided in paragraph 40 06 70-3.03.

SCADA: Display alarms. Display active and cleared-but-unacknowledged alarms in the alarm summary. SCADA allows Operator reset of alarms.

CS9 - DISCRETE LOGICAL POINT STATUS*

The status of each discrete logical point will also be maintained in the PLC. Discrete logical points are points which depend upon the status of one or several discrete input points. For example, equipment failed logical status will result from a loss of ready status when running. Loss of ready status when NOT running will not result in a failed logical status.

SCADA: Display the status of all discrete and logical discrete status points.

CS10 - ANALOG POINT STATUS*

Analog input points will be checked by the PLC for the following status conditions:

Failed: Point value is less than or greater than the specified value range typically less than 3.6 milliamps (mA) and greater than 21.6 mA.

SCADA: Display alarm. Display active and cleared-but-unacknowledged alarm in the alarm summary

CS11 - EQUIPMENT FAILURE*

The failure of PLC controlled equipment (pumps, blowers, compressors, fans, etc.) will be monitored by the PLC system. Equipment will be considered failed under the following conditions:

1) The equipment is in AUTO and the PLC system attempts to operate the equipment and it does not respond within a defined time period, typically for 30 seconds.
2) The equipment is in AUTO and running and for whatever reason other than the PLC system requesting the equipment to “STOP,” the equipment stops.

CS12 – PLCINPUTS AND OUTPUTS STATUS*

The PLC will monitor status of each individual input, output, communication module, and all processor statuses available.

SCADA: Display racks with status for each module, using descriptive terms for alarms. Display processor battery status. Display alarms. Display active and cleared-but-unacknowledged alarm in the alarm summary

CS13 - GENERAL RECORDING SYSTEM*

The Remote SCADA workstation will store historical input point data and generate reports based upon process variables (pressure, flow, temperature, level and analytical) and equipment status (speed, and motor current or run/off status) in real-time and from recent historical data. The exact report requirements will be determined by the OWNER and will be configured by others during the project construction period.

CS15 - GENERAL PROCESS CONTROL FUNCTION (ANALOG) SYSTEM

All analog control functions will be provided as required and will include but not be limited to the following:

1) Proportional-Integral-Derivative (PID) Control--Standard controller functions with balance-less, bump-less transfer from manual to automatic, manual overrides, external reset and output summing capabilities. Provision for cascade, rationing gain, bias, lead-lag, dead-time, feed forward and feedback control will be available.
2) SCADA display system will have a common PID controller operator interface for all equipment utilizing PID control. Controller operator interface will include alphanumeric and graphic indication of the following features as a minimum:
    a) ID of controlled equipment.
    b) ID of process variable input.
    c) Controller setpoint value.
    d) Process variable value.
    e) Controller output value.
    f) Setpoint adjustment interface.
    g) Indication if setpoint is under HAND or AUTO control.
    h) Local/Manual control output adjustment interface.
    i) Indication if control output is under local/manual control or under control of process controller.
3) Computational Functions--On-line mathematical functions will be available to provide real-time computational capability of control variables for use in feed-forward and other advanced control functions.

Appropriate control action(s) will be provided as needed.

CS16 - TREND PLOTS*

SCADA workstations will graphically plot trends of process variables (pressure, flow, temperature, level and analytical), controller setpoints, and equipment status (motor current) in real-time and from historical data, whether or not specific control strategies are provided. The plant operator will be able to select the plotting interval, within the limits of the actual data collection. Four trends per display view will be possible.

In addition to the plotted data, a trend will include:

1) Time.

2) Date.
3) Tag number.
4) Plotting interval.
5) Time at start.
6) Time at latest value.

CS17 – COLOR NOTATION FOR DYNAMIC OBJECTS ON CONTROL GRAPHIC DISPLAY SCREENS*

All dynamic objects on control graphic display screens will be provided with multiple-color display to identify status as tabulated below:

Equipment	Status	Required color
Motor	Running	Red
Motor	Ready or Off	Green
Valve/ Gate	Opened position	Red
Valve/ Gate	Closed position	Green
All	Power on	White
All	Abnormal condition	Amber (Yellow)
All	Advisory, Control Mode	Blue

CS18 - DIGITAL ALARM SYSTEM*

Alarms as shown on the P&ID will be determined and maintained by the PLC, whether or not specific control strategies are provided. Digital inputs can be from field instruments (level switches, pressure switches, etc.), local control panels (relay outputs, alarm module outputs, switches), and packaged systems (designated terminals with packaged units).

SCADA: Display alarms. Display active and cleared-but-unacknowledged alarms in the alarm summary.

CS19 - DATA ARCHIVING HISTORIAN AND HISTORICAL FUNCTIONS

Refer to CS16.

CS20 - digital status system*

Digital input status will be displayed on SCADA screens as required by the reference drawings and specifications regardless whether or not specific control strategies are provided. Each digital input will be shown in its appropriate process screen and/or equipment status screen.

Digital inputs can be originated from field instruments (motorized actuators, HVAC related air handling units, power management related contact inputs, level switches,

pressure switches, etc.), local control panels (relay outputs, alarm module outputs, switches), and packaged systems (designated terminals with packaged units).

CS24 - DATA TRANSFER REQUIREMENTS BETWEEN THE PLC's AND THE SCADA SYSTEM

Digital inputs and analog inputs to the SCADA system and the software logic generated alarms will be displayed or annunciated at the SCADA workstation as shown on P&IDs, the Instrument Index paragraph 40 06 70-3.03, and this Section. The SCADA system will generate separate alarms if communication is lost with any PLC.

CS31 – INTRUSION ARM/DISARM

Intrusion alarm disarming is from a keypad located outside. Manual reset of the alarm is required at SCADA.

Upon opening of doors or reservoir hatch, a PLC timer will be initiated. The timer will continue even if the door or hatch is re-closed. The Operator must enter the disarm code at the keypad within 5 minutes. Otherwise, an intrusion alarm will be indicated when the timer expires by the PLC to SCADA.

After disarming, the PLC will re-arm the alarm timer one hour after all doors and the hatch are all closed. If a door or hatch is left opened for more than 8 hours, the PLC will re-arm the alarm as this would likely indicate that work on the site is complete but something was left opened.

CS34 - EQUIPMENT RUN STATUS

Equipment start/stop control based on run status of other equipment, hardwired or PLC.

CS35 – SEAL FLUSH

Pump seal water flush solenoid valve open/close control based on run status of associated equipment, hardwired. Solenoid should be normally opened type, verify.

CS36 – BEARING FLUSH

Pump bearing water flush solenoid valve open/close control based on run status of associated equipment, hardwired. Solenoid should be normally opened type, verify.

CS37 – BEARING LUBRICATION

Lubrication oil solenoid valve open/close control based on run status of associated equipment, hardwired. Solenoid should be normally opened type, verify.

CS38 – TRAP PRIMER

Trap primer solenoid valve open/close control based on interval and duration timers, hardwired or PLC. Solenoid should be normally closed type, verify.

CS39 – ALTERNATION

Equipment run-time equalization by alternating the lead/lag assignment of two or more equipment items, hardwired or PLC. Hardwired: Alternation occurs when all equipment items stop. PLC: Alternation occurs by SCADA Operator request.

CS40 – PUMP LEAD/LAG SEQUENCING

Pump control in Auto by level switches, hardwired only. Lead pump starts upon medium level. Lag pump starts upon high level. Pumps stop upon low level.

CS41 – PUMP LEVEL CONTROL

Pump control in Auto by level switches, hardwired only. Pump starts upon high level. Pump stops upon low level.

CS42 – PUMP REDUNDANT LEVEL CONTROL

Pump control in Auto by level switches, hardwired only. Pump starts upon high-high level. Pump stops upon low-low level. This is typically specified in sewage pumping stations, to insure that at least some pumps will be started in the event of PLC control system failure to prevent a reportable issue.

CS43 – VALVE OPENS WHEN EQUIPMENT RUNS

Valve open/close control based on run status of other equipment, hardwired or PLC. Typical for spray valves.

CS44 - HYDROPNEUMATIC TANK – ADD AIR

Solenoid Valve control by level and pressure switches, hardwired only. Valve opens upon high level. Valve closes upon high pressure or when level falls below high level switch setting.

CS45 – HYDROPNEUMATIC TANK – VENT AIR

Solenoid Valve control by level switch, hardwired only. Valve opens upon low level. Valve closes when level rises above low level switch setting.

CS50 – ALARM WHEN NOT RUNNING

PLC generated alarm if unit is not running for 30 seconds, self-resetting.

CS51 – ALTERNATION - SOFTWARE

Equipment run-time equalization by alternating the lead/follow/2nd follow/etc. assignment of two or more pumps, PLC. Alternation occurs when all of the pumps in that group stop. Similarly, alternation occurs for the last group of pumps occurs when all of the pumps in that group stop. Upon failure of a pump, the standby pump is assigned in place of the failed pump. A typical PLC determined fail alarm for each pump includes:

Hardwired pump equipment related shutdowns (determined by the Process/Mechanical Engineer) including, but not limited to: High motor temperature, VFD fault, and submersible pump moisture detected if applicable. Normally reset at the VFD.

VFD selector switch removal from the AUTO position. Reset at the selector switch.

Equipment failure, refer to CS11 above.

Speed discrepancy in control system speed signal vs. VFD feedback speed, refer to CS61 - Variable Frequency Drive Speed below.

CS61 – VARIABLE FREQUENCY DRIVE SPEED

The minimum pumping speed shall be configured into the VFD for both HAND and AUTO modes, preventing unintentional under-speed and motor overheating in either mode. The PLC shall not be configured to provide an artificial zero of the 4-20 milliAmp (mA) or related network control signal, such as 12-20mA to prevent under-speed in VFD AUTO mode. The requirement to configure the VFD minimum speed setting at the VFD is included in Part 3 of Section 26 29 23.

Although the minimum pumping speed must be configured into the VFD for following the control system speed signal, the feedback speed configuration is a separate VFD setting.

This setting shall be left at default, with 4 milliAmps or zero network value for 0% speed and 20 milliAmps or 100% network value for 100% speed. Display of speed on the SCADA system shall reflect 0% when the pump is stopped and 100% when the pump is running at full speed.

One component of PLC determined pump failure is speed discrepancy as mentioned in CS51 above. The control system speed signal range is instead 0% for minimum pumping speed rather than 0% speed. For comparison with the control system speed signal, the feedback speed range must then be extrapolated from minimum pumping speed to maximum pumping speed for 0% to 100% and clamped to prevent a negative speed value by the PLC. Speed discrepancy in control system speed signal vs. VFD feedback speed is determined by the PLC when they deviate from each other by 10% or more for twenty seconds. The alarm is monitored by and requires reset from the SCADA system.

The PLC minimum feedback pumping speed for the calculation shall match the VFD configured setting for the control signal. Verification of the calculation is performed by comparing PLC calculated speed feedback with PLC control system speed signal at various steady VFD speeds.

CS71 – MOTORIZED VALVE OR GATE CONTROL - ISOLATING

Valve control in AUTO. When control requests the valve to open, the valve control open command signal is activated until the valve signals opened position. When control requests the valve to close, the valve close command signal is activated until the valve signals closed position. Includes CS75.

CS72 – MOTORIZED VALVE OR GATE CONTROL – MODULATING - ANALOG

Valve control in AUTO. When control requests a valve position in % opened, the valve control analog signal is set to the % opened required. Includes CS75.

CS73 – MOTORIZED VALVE OR GATE CONTROL – MODULATING - DISCRETE

Valve control in AUTO. When control requests a valve position in % opened, the valve control open command discrete signal or close command discrete signal is activated until the valve signals the % opened position required. Includes CS75.

CS75 – VALVE OR GATE FAILURE

The failure of control valves or gates will be monitored by the PLC system. Valve or gate actuators will be considered failed under the following conditions:

1) The isolating actuator is in AUTO and the PLC system attempts to open or close the valve or gate and it does not respond within a defined time period. Time delay field set based on testing, initial setting 60 seconds for valves, 240 seconds for gates.
2) The modulating actuator is in AUTO and the PLC system attempts to change position of the valve or gate and it does not respond within 2% of valve position within a defined time period. Time delay field set based on testing using a change from 0 to 100% opening, initial setting 60 seconds for valves, 240 seconds for gates.

3.10 CONTROL STRATEGY – RAW WATER (RW) TANK

A. Reference Drawings: Intake PS C-005, LeChee WTP I-10-101.

B. Description:

1. Raw water is provided from Lake Powell through the Intake PS to maintain the LeChee Water Treatment Plant (WTP) RW Tank level.
2. The maximum capacity of the raw water Intake PS system is designed to be 700 gpm. Initial operating flowrates may be less due to lower water demands.
3. Pumps are variable speed.
4. At the Intake PS, there is one duty stage 1 and one duty stage 2 pump, and one standby stage 1 and one standby stage 2 pump.
5. The submersible stage 1 pump provides sufficient suction pressure for the stage 2 pump prior to starting and during pumping.
6. The stage 2 pump provides pumping energy to fill the RW Tank.
7. The Intake pumps may be cross-valved so that pump A stage 1 can pump to pump A or B of stage 2, and pump B stage 1 can pump to pump A or B of Stage 2. Operator SCADA selection must match the pump stage 1 discharge to stage 2 suction valving. Cross-valving disables pump alternation.
8. A backpressure relief valve provides relief of surge pressure to the existing Intake PS sump.

C. Control Descriptions:
1. The Intake PS pumps are normally operated in AUTO mode. In this mode, start/stop and speed is controlled by the PLC to maintain RW Tank level.
2. The RW Tank level is forwarded from the WTP Telemetry PLC to the Intake PS Telemetry PLC via radio.
3. When tank level falls below the RW Tank Start Level Setpoint (adjustable at Intake PS Telemetry PLC OIS), the duty stage 1 pump is called to start by the Intake PS Telemetry PLC.
4. The duty stage 1 pump speed ramps up and pump speed is controlled by the Intake PS Telemetry PLC to maintain stage 1 discharge pressure to stage 2 pump suction. Pump speed ramp-up minimum time is 2 minutes.
5. Upon duty stage 1 pump discharge reaching setpoint pressure, the duty stage 2 pump is called to start by the Intake PS Telemetry PLC and is called to ramp to full speed. Stage 2 VFD configuration must limit ramp time from minimum (not zero) to maximum pumping speed to 2 minutes or more for pipeline hydraulic considerations.
6. When the tank level rises above the RW Tank Stop Level Setpoint (adjustable at Telemetry PLC OIS), the duty stage 2 pump is called to ramp to stop. Stage 2 VFD configuration must limit ramp time from maximum to minimum pumping speed to 2 minutes or more for pipeline hydraulic considerations.
7. The duty stage 1 pump is then called to stop by the Intake PS Telemetry PLC.
8. Stage 1 and stage 2 pump pairs alternate automatically, unless in cross-valved operation per Description paragraph above.
9. Raw water flow from the Intake PS measured at the RW Tank inlet is forwarded from the WTP Telemetry PLC to the Intake PS Telemetry PLC.
10. Raw water flow from the Intake PS to the RW Tank Inlet is compared to the Intake PS discharge flow. If the difference between flows exceeds 5% for 15 minutes, a pipe leak alarm is determined. The comparison is inhibited whenever there is a Telemetry communications failure between the WTP and the Intake PS Telemetry PLCs. Manual reset at the Intake PS Telemetry PLC OIS is required.

11. In the event of utility power failure, pumps will stop due to loss of power. In the event that pumps are operating on standby power and utility power is restored, the pumps will be called to stop when the automatic transfer switch returns to the utility power position. This is required as the transfer switch does not provide for phase synchronized make-before-break transfer from standby to utility power, to prevent motor generated back-EMF from tripping circuit breakers.
12. Pumps will restart on standby or return to utility power in the same mode, number of pumps, and speeds as they were running before. The stage 1 duty pump will be called to start first, followed by the stage 2 duty pump as described above.
13. Setpoints:

Intake PS Stop Level Setpoint	30.0 feet
Intake PS Start Level Setpoint	20.0 feet
Intake PS Stage 2 Inlet Pressure Setpoint	15.0 psig default, range TBD psig to TBD psig adjustable
WTP - RW Tank High High Level Alarm Setpoint	30.7 ft (4351.3 ft EL) default, range 26.2 ft (4346.8 ft EL) to 31.2 ft (4351.8 ft EL) adjustable
WTP - RW Tank Low Low Level Alarm Setpoint	19.5 ft (4340.1 ft EL) default, range 18.0 ft (4338.6 ft EL) to 23.0 ft (4343.6 ft EL) adjustable

14. Standard Control Strategies per 40 61 96-3.02:

    CS2 – FLOW TOTALIZATION

    CS15 - GENERAL PROCESS CONTROL FUNCTION (ANALOG) SYSTEM

    CS24 - DATA TRANSFER REQUIREMENTS BETWEEN THE PLC's AND THE SCADA SYSTEM

    CS51 – ALTERNATION - SOFTWARE
15. Standard Interlocks per 40 61 96-3.01:

    I1 – MOTOR PROTECTION

    I2 – HIGH DISCHARGE PRESSURE

    I3 – HIGH MOTOR TEMPERATURE

    I10 – HIGH MOISTURE (Stage 1)
16. Software Interlocks: None.

D. Local Control:
    1. Field:

       Tank Level

       Suction Pressure

       Discharge Pressure
    2. VFD/MCC:

       VFD Keypad

       HAND-OFF-AUTO selector

       VFD SPEED potentiometer

       RUN pilot

VFD FAULT pilot
HIGH MOTOR TEMPERATURE pilot
HIGH DISCHARGE PRESSURE pilot
MOISTURE pilot (Stage 1)
ELAPSED TIME HOURS indicator
RESET pushbutton

3.11 CONTROL STRATEGY – QUAGGA MUSSEL FEED

A. Reference Drawings: Intake PS E-106, E-107, and NTUA Technical Provisions PLC Control Panel Sheets 2 and 3a of 6.

B. Description:
   1. Refer to Section 43 13 13.
   2. Pump operates to inhibit Quagga Mussels. Chemical is injected between the stage 1 and 2 pumps.
   3. Pump is variable speed.

C. Control Descriptions:
   1. The pump is normally operated in AUTO mode. In this mode, start/stop is controlled by the Telemetry PLC when both one stage 1 and one stage 2 pump are running.
   2. The pump speed ramps up and pump speed is controlled by the Telemetry PLC based on raw water stage 2 discharge flow. Speed is controlled to provide an injection rate of 5 ppm (0.0003 gph of chemical per gpm of raw water flow). The Telemetry PLC shall be programmed to provide the required injection dosing, with the pump configured for 4mA signal for 0% speed, and 20mA for 100% speed/capacity.
   3. Standard Control Strategies per 40 61 96-3.02:
      CS34 - EQUIPMENT RUN STATUS (STAGE 1 AND 2 PUMP RUNNING)
      CS61 – VARIABLE FREQUENCY DRIVE SPEED
   4. Standard Interlocks per 40 61 96-3.01:
      I1 – MOTOR PROTECTION
   5. Software Interlocks: None.

D. Local Control:
   1. Field: None.
   2. VFD/MCC:
      VFD Keypad
      HAND-OFF-AUTO selector

3.12 CONTROL STRATEGY – RAW WATER (RW) FEED PUMPS

A. Reference Drawings: I-21-101, I-22-102.

B. Description:

1. The raw water feed pumps provide the driving head needed to pump raw water from the raw water tank across a raw water automatic backwash strainer, through the membrane treatment process and GAC process and into the finished water tank.
    a. The system has two duty pumps with space reserved for a third pump and strainer to service a future membrane treatment train.
    b. A separate VFD controls the speed of the pump motor to maintain a specific flow rate through the membrane filtration skid.
    c. Each pump operates against a pressure sustaining valve (PSV) downstream of the strainer, allowing each pump to operate against a discharge pressure independent of the transmembrane pressure across the membrane modules. Pump discharge pressure will remain nearly constant, only varying based on the differential pressure across the automatic backwash strainer. However, this variation is anticipated to be small based on the minimal debris in the raw water.
    d. The upstream pressure in the raw water piping feeding each pump will vary based on the water surface elevation in the raw water tank, which will require adjustment to pump speed to maintain the specified flow rate as the differential pressure across the pump will not remain constant as water surface elevations vary in the raw water tank.
    e. The minimum surface water elevation defined for the raw water tank and the constant back pressure provided by the PSV intentionally restricts pump operation to the stable region of the pump curve. This approach minimizes the potential for cavitation, excessive vibration and unstable flow characteristics which significantly reduce the operational life of the equipment while allow the pump to safely operate across the wide range of operating flow rates required for this application.
    f. Each pump is sized provide the membrane treatment skid with raw water at flow rates between approximately 200 to 600 gpm during operation and up to 15 gpm/installed membrane module during the forward flush sequence of the backwash cycle.
    g. Additionally, each pump provides the driving pressure required to perform a backwash sequence for the automatic backwash strainer.
2. The raw water automatic backwash strainers protect the downstream membrane treatment train from larger debris in the raw water feed when present.
    a. Each raw water feed pump has a raw water filter downstream of its discharge that removes particulates larger than 500 µm (0.02 in)
    b. Each strainer is physically connected with one raw water pump, meaning a strainer can only be paired to the pump it physically connected with. Thus, the pump and automatic backwash strainer operate as a unit.
    c. The location of the PSV downstream of the strainer ensures the system maintains sufficient pressure in the strainer body for backwashing the strainer system, even in the event that the valve immediately downstream of the automatic backwash strainer must remain open to allow the pump to bypass excess flow during a backwash to ensure the pump remains in a stable region of the pump curve at all times.
    d. The Automatic Backwash Strainer removes debris passively from the raw water feed, meaning the motor only moves the internal components during a backwash sequence and remains stationary during normal operation.

3. Each pump and automatic backwash strainer unit physically connect to one membrane treatment skid. Thus, the pump and automatic backwash strainer unit can only be paired to the membrane treatment skid it physically connects with. Therefore, failure of one of these three components (pump, automatic backwash strainer, or component on the membrane treatment skid) will result in that train, in its entirety, going offline.

C. Control Descriptions:
   1. The pumps are normally operated in AUTO mode. In this mode, start/stop and speed is controlled by the PLC to maintain setpoint flow to membrane filtration.
   2. The filters are normally operated in AUTO mode. In this mode, the filter is called to start when the selected pump is running.
   3. Filter flushing is controlled by the filter LCP upon high differential pressure or if not operated within a set .
   4. The Membrane LCP requests start/stop of one or two RW pumps and filters from the Treatment PLC for operation of one or two membrane filtration skids.
   5. The Membrane LCP provides each membrane filtration skid flow signal and flow setpoint to the Treatment PLC. Each selected pump speed is independently controlled by the Treatment PLC to control flow rate to the selected membrane .
   6. When a pump is running, the associated discharge solenoid valve to the Turbidity Meter Panel is called to open, so that Raw Water Turbidity may be determined.
   7. In the event of utility power failure, pumps will stop due to loss of power. In the event that pumps are operating on standby power and utility power is restored, the pumps will be called to stop when the automatic transfer switch returns to the utility power position. This is required as the transfer switch does not provide for phase synchronized make-before-break transfer from standby to utility power, to prevent motor generated back-EMF from tripping circuit breakers.
   8. Pumps will restart on standby or return to utility power in the same mode, number of pumps, and speeds as they were running before. Pumps will be delay-started by the PLC, however. Pump 1 will be restarted 5 seconds after power availability, Pump 2 will be restarted 10 seconds after that (if still called for by the Membrane LCP).
   9. Setpoints:

Membrane LCP - Membrane Filtration Inlet Flow Setpoint	250.0 gpm default, range 200.0 gpm to 650.0 gpm adjustable

   10. Standard Control Strategies per 40 61 96-3.02:
       CS3 - PROCESS ALARM(S), SELF-RESETTING - LOW LOW SUCTION (RW) TANK LEVEL
       CS15 - GENERAL PROCESS CONTROL FUNCTION (ANALOG) SYSTEM
       CS34 - EQUIPMENT RUN STATUS (FILTER)
       CS43 – VALVE OPENS WHEN EQUIPMENT RUNS
       CS61 – VARIABLE FREQUENCY DRIVE SPEED
   11. Standard Interlocks per 40 61 96-3.01:
       I1 – MOTOR PROTECTION
       I3 – HIGH MOTOR TEMPERATURE

12. Software Interlocks: None.

D. Local Control:
   1. Field:
      Suction Pressure
      Discharge Pressure
   2. VFD/MCC:
      VFD Keypad
      HAND-OFF-AUTO selector
      VFD SPEED potentiometer
      RUN pilot
      VFD FAULT pilot
      HIGH MOTOR TEMPERATURE pilot
      LOW FLOW pilot
      ELAPSED TIME HOURS indicator
      RESET pushbutton

3.13 CONTROL STRATEGY – RAW WATER (RW) TURBIDITY PANEL

E. Reference Drawings: I-21-101, I-22-101.

F. Description:
   1. The Raw Water Turbidity Panel measures the turbidity of the raw water pumped from the raw water tank prior to entering the membrane treatment skid to monitor and record incoming water quality within the Membrane LCP.
      a. A solenoid valve located on a branch immediately downstream of the automatic backwash strainer discharge on each treatment train opens when the treatment train is online to provide a steady flow of raw water, pressurized by the feed pump, to the turbidity panel shared by all treatment trains.
      b. The location of the branch downstream of the automatic backwash strainer minimizes the potential for larger debris entering the sample lines and clogging the system.
      c. Sample flows from each treatment train combine to provide a single line to the turbidity panel for measurement. As such, the turbidity panel does not measure the turbidity separately for each treatment train online.
      d. The purpose of the solenoid valve is to isolate the treatment train when the train is not online rather than opening and closing during operation to allow the system to take individual turbidity readings when both trains are online.
      e. A second solenoid valve, located downstream of the raw water turbidity sensor opens when at least one treatment train is in service to allow the sample water to drain into the backwash wastewater system. As a part of the raw water turbidity panel, this valve is shared by all treatment trains.

G. Control Descriptions:
   1. When any Raw Water feed Pump is running, the discharge solenoid valve to the Turbidity Meter Panel is called to open, so that Raw Water Turbidity may be determined.

2. Standard Control Strategies per 40 61 96-3.02:
   CS43 – VALVE OPENS WHEN EQUIPMENT RUNS
3. Standard Interlocks per 40 61 96-3.01: None.
4. Software Interlocks: None.

H. Local Control:
1. Field:
   Turbidity
2. VFD/MCC: None.

3.14 CONTROL STRATEGY – MEMBRANE TREATMENT PROCESS

A. Reference Drawings: I-22-102; -104; and -106.

B. Description:
1. Refer to Spec. 46 61 33.
2. The membrane treatment process uses ultrafiltration membranes to filter the raw water fed by the raw water pump on the same train before discharging the permeate into the membrane filtration effluent system to monitor and record permeate water quality within the Membrane LCP.
   a. The system consists of two membrane treatment trains with space for a future third membrane treatment train when community demands dictate the need.
   b. Each membrane skid consists of a valve rack, which directs raw water, backwash water, CIP Solution, and air (both low pressure and compressed) in and out of the module rack on the same treatment train.
   c. The valve rack and membrane module rack in each train is sized to minimize the amount of chemicals used at the facility, maximize the lifespan of the membrane modules themselves and allow one treatment train to meet the rated plant capacity with one treatment train offline. This approach provides the N+1 redundancy desired for this process.
   d. The Membrane LCP controls the processes within the membrane treatment process to test, operate, backwash and clean the membrane modules as necessary to optimize performance and ensure satisfactory water quality.
   e. The Treatment PLC provides the Membrane LCP with a flow demand, which the Membrane LCP uses to determine the number of treatment trains required to meet the demand and control the processes within the membrane treatment process to test, operate, backwash and clean the membrane modules as required to optimize performance and ensure satisfactory water quality.
   f. The Membrane LCP controls the sequence of events associated with the various processes of the membrane treatment system (production, backwash, maintenance clean, recovery clean, membrane integrity test, etc.). Although the plant PLC will have information regarding the state and position of the various components in the system (pumps, valves, compressors, blowers, etc.), the state of those components (e.g., on/off, open/close) is dictated through the Membrane LCP.
   g. Additionally, the Membrane LCP will provide the Treatment PLC with data from the various instruments and calculations performed by the Membrane LCP specifically for monitoring the processes within each membrane treatment train.

However, operators cannot modify operating parameters (such as whether a specific treatment train is online or whether a valve is opened or closed) through the Treatment PLC. Any adjustment to the membrane treatment system will occur through the Membrane LCP HMI.

C. Control Descriptions:
   1. The skids are normally operated in AUTO mode. In this mode, start/stop is controlled by the Membrane LCP.
   2. Standard Control Strategies per 40 61 96-3.02: None.
   3. Standard Interlocks per 40 61 96-3.01: None.
   4. Software Interlocks: None.

D. Local Control:
   1. Field:
      Permeate Pressure
      Permeate Temperature
   2. VFD/MCC:
      LCP Keypad

3.15 CONTROL STRATEGY – PERMEATE TURBIDITY

A. Reference Drawings: I-21-103; -105; and -107.

B. Description:
   1. The Permeate Water Turbidity Panel measures the turbidity of the permeate leaving the valve rack on each membrane treatment train prior to entering the membrane filtration effluent system.
      a. A solenoid valve located on a branch on the valve rack of each train opens when the treatment train is online to provide a steady flow of water, pressurized by the remaining pressure downstream of the membrane modules to the permeate turbidity panel located on each valve rack. As such, the permeate panel measures the turbidity of the permeate of the valve rack it is mounted to.
      b. A second solenoid valve, located downstream of the permeate water turbidity sensor opens when the treatment train is in service to allow the sample water to drain into the backwash wastewater system.

C. Control Descriptions:
   1. When the selected RW pump for the associated membrane is running, the permeate solenoid valve to the Permeate Tank is called to open.
   2. When the permeate solenoid valve for the Permeate Tank has been called to open, the solenoid valve to the Turbidity Meter Panel is called to open, so that Permeate Turbidity for the membrane may be determined.
   3. Standard Control Strategies per 40 61 96-3.02:
      CS43 – VALVE OPENS WHEN EQUIPMENT RUNS
   4. Standard Interlocks per 40 61 96-3.01: None.

5. Software Interlocks: None.

D. Local Control:
   1. Field:
      Turbidity
   2. VFD/MCC: None.

3.16 CONTROL STATEGY – MEMBRANE BACKWASH PUMPS

A. Reference Drawing: I-22-108

B. Description
   1. The membrane backwash Pumps provide each treatment train with permeate water stored in the backwash water tank for use during the backwash sequence.
      a. The system has one duty and one standby pump.
      b. Each pump operates against a downstream pressure primarily a result of the transmembrane pressure of the ultrafiltration modules, which will vary based on a number of factors (e.g. the initial solid load on the membrane surface at the start of the backwash cycle, elapsed time in the backwash cycle, last CIP recovery clean).
      c. A separate VFD controls the speed of each pump motor to maintain a specified flow rate, as pressure varies throughout the cycle, to a specific membrane valve rack during a backwash sequence. The Membrane LCP provides the treatment PLC with the specified flow rate.
      d. A shared flow meter, on the piping downstream of the backwash pumps, measures the flow rate, which the VFD uses to maintain the flow rate to the specific valve rack.
      e. The upstream pressure in the backwash water piping feeding each pump will vary based on the water surface elevation in the backwash tank, which will require a small adjustment to pump speed to maintain the specified flow rate as the differential pressure across the pump will not remain constant as water surface elevations vary in the backwash tank.
      f. Each pump is sized provide the membrane treatment skid with backwash water at flow rates between approximately 320 to 440 gpm , allowing up to 10 gpm/installed membrane module during the backwash sequence of the backwash cycle.

C. Control Descriptions
   1. The pumps are normally operated in AUTO mode. In this mode, start/stop and speed is controlled by the Membrane LCP to maintain setpoint flow to membrane filtration.
   2. When Backwash is requested, the recirculation valve is called to open sending discharge back to the tank for mixing, and the duty Backwash pump is called to start at full speed.
   3. In the event of utility power failure, pumps will stop due to loss of power. In the event that pumps are operating on standby power and utility power is restored, the pumps will be called to stop when the automatic transfer switch returns to the utility power position. This is required as the transfer switch does not provide for phase

synchronized make-before-break transfer from standby to utility power, to prevent motor generated back-EMF from tripping circuit breakers.

4. Setpoints:

Membrane LCP – Backwash Flow Setpoint	250.0 gpm default, range 320.0 gpm to 400.0 gpm adjustable

5. Standard Control Strategies per 40 61 96-3.02:
   CS15 - GENERAL PROCESS CONTROL FUNCTION (ANALOG) SYSTEM
   CS61 – VARIABLE FREQUENCY DRIVE SPEED
6. Standard Interlocks per 40 61 96-3.01:
   I1 – MOTOR PROTECTION
   I2 – HIGH DISCHARGE PRESSURE
   I3 – HIGH MOTOR TEMPERATURE
7. Software Interlocks: None.

D. Local Control:
   1. Field:
      Tank Level
      Suction Pressure
      Discharge Pressure
      Discharge Flow
      Discharge Temperature
   2. VFD/MCC:
      VFD Keypad
      HAND-OFF-AUTO selector
      VFD SPEED potentiometer
      RUN pilot
      VFD FAULT pilot
      HIGH DISCHARGE PRESSURE pilot
      HIGH MOTOR TEMPERATURE pilot
      ELAPSED TIME HOURS indicator
      RESET pushbutton

3.17 CONTROL STRATEGY – MEMBRANE CLEANING IN PLACE (CIP) PUMPS

A. Reference Drawings: I-22-109.

B. Description:
   1. The CIP Pumps provide each treatment train with a chemical solution each treatment train with various types of chemical solutions used to optimize the performance of the ultrafiltration membrane modules over its lifespan.
      a. The system has one duty and one standby pump.

b. The cleaning cycles are separated into two types (primarily based on duration): maintenance cleans (performed between recovery cleans) and recover cleans.

c. Additionally, the pumps circulate the cleaning solution through the heater (as required) and to and from the chemical dosing area of the plant to prepare the chemical solution for a maintenance or recovery clean as well as neutralize the solution upon completion of the process prior to discharging the solution to the chemical drying beds.

a. Each pump operates against a downstream pressure primarily a result of the major and minor losses from the piping, valves and fittings.

b. A separate VFD controls the speed of each pump motor to maintain a specified flow rate, to a specific membrane valve rack during a recover or maintenance cleaning CIP process. The Membrane LCP provides the treatment PLC with the specified flow rate.

c. A shared flow meter, on the piping downstream of the CIP pumps, measures the flow rate, which the VFD uses to maintain the flow rate to the specific valve rack.

d. The upstream pressure in the CIP piping feeding each pump will vary based on the water surface elevation in the CIP tank, which will require a small adjustment to pump speed to maintain the specified flow rate as the differential pressure across the pump will not remain constant as water surface elevations vary in the CIP tank.

e. Each pump is sized provide the membrane treatment skid with backwash water at flow rates between approximately 200 to 250 gpm during the CIP processes.

C. Control Descriptions:

1. The pumps are normally operated in AUTO mode. In this mode, start/stop and speed is controlled by the Membrane LCP to maintain setpoint flow to membrane filtration.
2. When CIP is requested, the recirculation valve is called to open sending discharge back to the tank for mixing, and the duty CIP pump is called to start at full speed.
3. CIP discharge temperature is measured. If low, the heated recirculation valve is called to open sending heated discharge back to the tank for mixing, and the recirculation valve is called to close. Recirculation is heated until discharge temperature setpoint is reached, then the recirculation valve is called to open and the heated recirculation valve is called to close.
4. In the event of utility power failure, pumps will stop due to loss of power. In the event that pumps are operating on standby power and utility power is restored, the pumps will be called to stop when the automatic transfer switch returns to the utility power position. This is required as the transfer switch does not provide for phase synchronized make-before-break transfer from standby to utility power, to prevent motor generated back-EMF from tripping circuit breakers.
5. Setpoints:

CIP Flow Setpoint	250.0 gpm default, range 200.0 gpm to 300.0 gpm adjustable
CIP Temperature Setpoint	Set points determined by Membrane Manufacturer

6. Standard Control Strategies per 40 61 96-3.02:

   CS15 - GENERAL PROCESS CONTROL FUNCTION (ANALOG) SYSTEM

   CS61 – VARIABLE FREQUENCY DRIVE SPEED

7. Standard Interlocks per 40 61 96-3.01:
   I1 – MOTOR PROTECTION
   I2 – HIGH DISCHARGE PRESSURE
   I3 – HIGH MOTOR TEMPERATURE
8. Software Interlocks: None.

D. Local Control:
1. Field:
   Tank Level
   Suction Pressure
   Discharge Pressure
   Discharge Flow
   Discharge Temperature
2. VFD/MCC:
   VFD Keypad
   HAND-OFF-AUTO selector
   VFD SPEED potentiometer
   RUN pilot
   VFD FAULT pilot
   HIGH DISCHARGE PRESSURE pilot
   HIGH MOTOR TEMPERATURE pilot
   ELAPSED TIME HOURS indicator
   RESET pushbutton

3.18 CONTROL STRATEGY – SODIUM HYPOCHLORITE DOSING (MEMBRANE CIP)

A. Reference Drawings: I-22-111, I-22-110.

B. Description:
1. The sodium hypochlorite pumps dose sodium hypochlorite for the membrane maintenance and recovery cleaning process of the CIP system as well as to the backwash water tank to prevent biological growth (as needed).
   a. The system has one duty and one standby positive displacement pump.
   b. Both pumps draw from a common chemical drum and feed into a common dosing line with valves downstream of that point to direct the chemical solution to either the dosing point in the chemical area of the plant or to the backwash water tank.
   c. Each pump operates against a pressure sustaining valve located at each dosing point to provide a constant pressure for the pumps to operate against as well as prevent accidental dosing when the pumps our not operating.
   d. The pumps are driven by a motor capable of operating at variable speeds, controlled by the Membrane LCP.
   e. Each pump operates at a flow rate between 0.01 gpm and 1.2 gpm.

C. Control Descriptions:

1. The pumps are normally operated in AUTO mode. In this mode, start/stop and speed is controlled by the Membrane LCP.
2. Pumps are started and stopped when CIP system is running, to achieve a concentration of NaOCl of 500 mg/L during a maintenance or recovery clean. Additionally, pumps are started and stopped by the Membrane LCP as needed to provide a set dose of NaOCl to the backwash water tank, as necessary.
3. Speed is controlled by the Membrane LCP as needed to provide a steady dose into the solution.
4. Pumps alternate upon pump stop.
5. In the event of utility power failure, pumps will stop due to loss of power. In the event that pumps are operating on standby power and utility power is restored, the duty will be called to stop when the automatic transfer switch returns to the utility power position.
6. Pumps will restart on standby or return to utility power in the same mode, number of pumps, and speeds as they were running before.
7. Setpoints:

CIP residual chlorine Setpoint	500.0 ppm default, range 0.0 to 600.0 ppm adjustable

8. Standard Control Strategies per 40 61 96-3.02:
   CS15 – GENERAL PROCESS CONTROL FUNCTION (ANALOG) SYSTEM
   CS51 – ALTERNATION – SOFTWARE
9. Standard Interlocks per 40 61 96-3.01: None.
10. Software Interlocks: None.

D. Local Control:
   1. Field:
      Calibration Column
      Discharge Pressure
   2. VFD/MCC:
      HAND-OFF-AUTO selector
      VFD SPEED potentiometer
      RUN pilot

3.19 CONTROL STRATEGY – CITRIC ACID DOSING (MEMBRANE CIP)

A. Reference Drawings: I-22-112, I-22-110.

B. Description:
   1. The citric acid pumps dose a citric acid solution for the membrane maintenance and recovery cleaning process of the CIP system.
      a. The system has one duty and one standby positive displacement pump.
      b. Both pumps draw from a common chemical drum and feed into a common dosing line which doses the solution in the chemical area of the plant.

c. Each pump operates against a pressure sustaining valve located at the dosing point to provide a constant pressure for the pumps to operate against as well as prevent accidental dosing when the pumps our not operating.
d. The pumps are driven by a motor capable of operating at variable speeds, controlled by the Membrane LCP.
e. Each pump operates at a flow rate between 0.01 gpm and 1.2 gpm.

C. Control Descriptions:
1. The pumps are normally operated in AUTO mode. In this mode, start/stop and speed is controlled by the Membrane LCP.
2. Pumps are started and stopped when CIP system is running to achieve a concentration of 500 mg/L during a maintenance clean and up to 2000 mg/L during a recovery clean.
3. Speed is controlled by the Membrane LCP to provide a steady dose into the solution.
4. Pumps alternate upon pump stop.
5. In the event of utility power failure, pumps will stop due to loss of power. In the event that pumps are operating on standby power and utility power is restored, the duty will be called to stop when the automatic transfer switch returns to the utility power position.
6. Pumps will restart on standby or return to utility power in the same mode, number of pumps, and speeds as they were running before.
7. Setpoints:

CIP pH Setpoint	TBD by Membrane Manufacturer pH default, range 0.0 to 14.0 adjustable

8. Standard Control Strategies per 40 61 96-3.02:
CS15 – GENERAL PROCESS CONTROL FUNCTION (ANALOG) SYSTEM
CS51 – ALTERNATION – SOFTWARE
9. Standard Interlocks per 40 61 96-3.01: None.
10. Software Interlocks: None.

D. Local Control:
1. Field:
Calibration Column
Discharge Pressure
2. VFD/MCC:
HAND-OFF-AUTO selector
VFD SPEED potentiometer
RUN pilot

3.20 CONTROL STRATEGY – SODIUM BISULFITE DOSING (MEMBRANE CIP)

A. Reference Drawings: I-22-113, I-22-110.

B. Description:

1. The sodium bisulfite dosing pumps dose a sodium bisulfite solution into the chemical solution after completion of a membrane maintenance or recovery cleaning process of the CIP system for neutralization purposes.
    a. The system has one duty and one standby positive displacement pump.
    b. Both pumps draw from a common chemical drum and feed into a common dosing line which doses the solution in the chemical area of the plant.
    c. Each pump operates against a pressure sustaining valve located at the dosing point to provide a constant pressure for the pumps to operate against as well as prevent accidental dosing when the pumps our not operating.
    d. The pumps are driven by a motor capable of operating at variable speeds, controlled by the Membrane LCP.
    e. Each pump operates at a flow rate between 0.01 gpm and 1.2 gpm.
2. Pumps are variable speed.
3. There is one duty and one standby pump.

C. Control Descriptions:
1. The pumps are normally operated in AUTO mode. In this mode, start/stop and speed is controlled by the Membrane LCP.
2. Pumps are started and stopped when CIP pumps are running, to maintain CIP residual chlorine.
3. Speed is controlled to maintain CIP residual chlorine.
4. Pumps alternate upon pump stop.
5. In the event of utility power failure, pumps will stop due to loss of power. In the event that pumps are operating on standby power and utility power is restored, the duty will be called to stop when the automatic transfer switch returns to the utility power position.
6. Pumps will restart on standby or return to utility power in the same mode, number of pumps, and speeds as they were running before.
7. Setpoints:

CIP residual chlorine Setpoint	1.5 ppm default, range 1.0 to 3.0 adjustable

8. Standard Control Strategies per 40 61 96-3.02:
   CS15 – GENERAL PROCESS CONTROL FUNCTION (ANALOG) SYSTEM
   CS51 – ALTERNATION – SOFTWARE
9. Standard Interlocks per 40 61 96-3.01: None.
10. Software Interlocks: None.

D. Local Control:
1. Field:
   Calibration Column
   Discharge Pressure
2. VFD/MCC:
   HAND-OFF-AUTO selector

VFD SPEED potentiometer

RUN pilot

3.21 CONTROL STRATEGY – SULFURIC ACID DOSING (MEMBRANE CIP)

A. Reference Drawings: I-22-115, I-22-110.

B. Description:

1. The sodium bisulfite dosing pumps dose a sulfuric acid solution for the membrane maintenance and recovery cleaning process of the CIP system.
   a. The system has one duty and one standby positive displacement pump.
   b. Both pumps draw from a common chemical drum and feed into a common dosing line which doses the solution in the chemical area of the plant.
   c. Each pump operates against a pressure sustaining valve located at the dosing point to provide a constant pressure for the pumps to operate against as well as prevent accidental dosing when the pumps our not operating.
   d. The pumps are driven by a motor capable of operating at variable speeds, controlled by the Membrane LCP.
   e. Each pump operates at a flow rate between 0.01 gpm and 1.2 gpm.

C. Control Descriptions:

1. The pumps are normally operated in AUTO mode. In this mode, start/stop and speed is controlled by the Membrane LCP.
2. Pumps are started and stopped when CIP pumps are running, to maintain CIP pH.
3. Speed is controlled to maintain CIP pH.
4. Pumps alternate upon pump stop.
5. In the event of utility power failure, pumps will stop due to loss of power. In the event that pumps are operating on standby power and utility power is restored, the duty will be called to stop when the automatic transfer switch returns to the utility power position.
6. Pumps will restart on standby or return to utility power in the same mode, number of pumps, and speeds as they were running before.
7. Setpoints:

CIP pH Setpoint	2.1 pH default, range 0.0 to 14.0 adjustable

8. Standard Control Strategies per 40 61 96-3.02.
   CS15 – GENERAL PROCESS CONTROL FUNCTION (ANALOG) SYSTEM
   CS51 – ALTERNATION – SOFTWARE
9. Standard Interlocks per 40 61 96-3.01: None.
10. Software Interlocks: None.

D. Local Control:

1. Field:
   Calibration Column
   Discharge Pressure

2. VFD/MCC:
   HAND-OFF-AUTO selector
   VFD SPEED potentiometer
   RUN pilot

3.22 CONTROL STRATEGY – SODIUM HYDROXIDE DOSING (MEMBRANE CIP)

A. Reference Drawings: I-22-115, I-22-110.

B. Description:
   1. The sodium hydroxide dosing pumps dose a sodium hydroxide solution into the chemical solution after completion of a membrane maintenance or recovery cleaning process of the CIP system for neutralization purposes.
      a. The system has one duty and one standby positive displacement pump.
      b. Both pumps draw from a common chemical drum and feed into a common dosing line which doses the solution in the chemical area of the plant.
      c. Each pump operates against a pressure sustaining valve located at the dosing point to provide a constant pressure for the pumps to operate against as well as prevent accidental dosing when the pumps our not operating.
      d. The pumps are driven by a motor capable of operating at variable speeds, controlled by the Membrane LCP.
      e. Each pump operates at a flow rate between 0.01 gpm and 1.2 gpm.

C. Control Descriptions:
   1. The pumps are normally operated in AUTO mode. In this mode, start/stop and speed is controlled by the Membrane LCP.
   2. Pumps are started and stopped when CIP pumps are running, to maintain CIP pH.
   3. Speed is controlled to maintain CIP pH.
   4. Pumps alternate upon pump stop.
   5. In the event of utility power failure, pumps will stop due to loss of power. In the event that pumps are operating on standby power and utility power is restored, the duty will be called to stop when the automatic transfer switch returns to the utility power position.
   6. Pumps will restart on standby or return to utility power in the same mode, number of pumps, and speeds as they were running before.

   7. Setpoints:

CIP pH Setpoint	6.0 pH default, range 0.0 to 14.0 adjustable

   8. Standard Control Strategies per 40 61 96-3.02:
      CS15 – GENERAL PROCESS CONTROL FUNCTION (ANALOG) SYSTEM
      CS51 – ALTERNATION – SOFTWARE
   9. Standard Interlocks per 40 61 96-3.01: None.

10. Software Interlocks: None.

D. Local Control:
   1. Field:
      Calibration Column
      Discharge Pressure
   2. VFD/MCC:
      HAND-OFF-AUTO selector
      VFD SPEED potentiometer
      RUN pilot

3.23 CONTROL STRATEGY – MEMBRANE AIR SCOUR BLOWERS

A. Reference Drawings: I-22-116, I-22-102, I-22-104, and I-22-106.

B. Description:
   1. The air scour system provides pressurized air to a membrane treatment train during the backwash cycle to scour the fibers of the membrane module to remove solids through agitation.
      a. Refer also to Section 46 61 33.
      b. The system has one duty and one standby blower.
      c. A separate VFD controls the speed of each blower motor to maintain a specified pressure as measured from a specific membrane treatment train undergoing a backwash. The Membrane LCP provides the treatment PLC with the specified pressure.
      d. Blowers are sized to provide approximately 100-132 DCFM at 7.5 psig.
      e. The duty blower provides air to the membrane treatment train undergoing a backwash only through control of a separate valve located on the valve rack of each treatment train.

C. Control Descriptions:
   1. The blowers are normally operated in AUTO mode. In this mode, start/stop and speed is controlled by the Membrane LCP for the membrane filtration unit being cleaned.
   2. Blowers are started and stopped when CIP process calls for air scour.
   3. Speed is controlled to maintain setpoint pressure to the membrane filtration unit being cleaned. Pressure is measured on the membrane Permeate line.
   4. Upon being called to start, the blower discharge drain solenoid is called to close.
   5. After the blower is running, the air scour blower discharge valve on the valve rack for the membrane filtration unit is opened.
   6. When the blower is called to stop, the air scour blower discharge valve on the valve rack for the membrane filtration unit is closed.
   7. When the blower has stopped, the blower discharge drain solenoid is called to open.
   8. Blowers alternate upon blower stop.
   9. In the event of utility power failure, blowers will stop due to loss of power. In the event that blowers are operating on standby power and utility power is restored, the

duty blower will be called to stop when the automatic transfer switch returns to the utility power position.

10. Blowers will restart on standby or return to utility power in the same mode, and speeds as they were running before.
11. Setpoints:

CIP Air Scour Pressure Setpoint	7.5 psig default, range 6.0 to 8.0 adjustable

D. Standard Control Strategies per 40 61 96-3.02:

CS15 – GENERAL PROCESS CONTROL FUNCTION (ANALOG) SYSTEM

CS43 – VALVE OPENS WHEN EQUIPMENT RUNS

CS51 – ALTERNATION – SOFTWARE

CS61 – VARIABLE FREQUENCY DRIVE SPEED

1. Standard Interlocks per 40 61 96-3.01:

   I1 – MOTOR PROTECTION

   I3 – HIGH MOTOR TEMPERATURE
2. Software Interlocks: None.

E. Local Control:

1. Field:

   Discharge Pressure
2. VFD/MCC:

   VFD Keypad

   HAND-OFF-AUTO selector

   VFD SPEED potentiometer

   RUN pilot

   VFD FAULT pilot

   HIGH MOTOR TEMPERATURE pilot

   ELAPSED TIME HOURS indicator

   RESET pushbutton

3.24 CONTROL STRATEGY – COMPRESSED AIR

A. Reference Drawings: I-22-117, I-22-102, I-22-104, and I-22-106.

B. Description:

1. The compressed air system provides air for membrane integrity testing, and for membrane process pneumatically operated valves located throughout the plant.
   a. Refer also to Section 46 31 33.
   b. The system is configured to pressurize two compressed air tanks, each pressurized by a separate constant speed compressor. The system consists of one lead and one lag compressor. However, both tanks are interconnected allowing the lead compressor to pressurize both tank.

c. System will maintain a constant pressure in the tanks. Should demands increase beyond the capacity of a single compressor and pressure in the system downstream of the tank decrease below the set point of the first pressure switch, the lag compressor will come online to provide additional capacity.

C. Control Descriptions:
1. The compressors are normally operated in AUTO mode. In this mode, start/stop of the duty compressor is controlled by pressure switches.
2. Compressors alternate upon compressor stop.
3. The air receiver drain solenoid valve is self-operated and opens periodically.
4. The air dryer drain solenoid valve for valve compressed air is self-operated and opens periodically.
5. When the Membrane LCP calls for a skid membrane integrity test:
a. The two skid membrane integrity discharge valves on the valve rack for the membrane filtration skid being cleaned are opened. The Membrane LCP determines membrane integrity based on Permeate line pressure.
b. After testing, the rack downstream integrity valve is called to close and the integrity air relief valve on the valve rack for membrane filtration unit being cleaned is opened momentarily. Then this valve is closed, and the rack upstream integrity valve is called to close.
6. Standard Control Strategies per 40 61 96-3.02:

CS39 – ALTERNATION
7. Standard Interlocks per 40 61 96-3.01:
I1 – MOTOR PROTECTION
8. Software Interlocks: None.

D. Local Control:
1. Field: None.
2. VFD/MCC:
HAND-OFF-AUTO selector
RUN pilot
FAIL pilot
RESET pushbutton

3.40 CONTROL STRATEGY – GRANULAR ACTIVATED CHARCOAL (GAC) FILTERING

A. Reference Drawings: I-23-101; -102; and -103.

B. Description:
1. The GAC system treats the permeate from the ultrafiltration system to reduce the total organic carbon (TOC) in the water to minimize the formation of disinfection byproducts (DBPs), namely Trihalomethanes (THMs) and Haloacetic Acids (HAAs).
a. The system consists of three large vertical pressure vessels, each with approximately 10,000 lbs of Granular Activated Carbon (GAC) media.
b. The vessels are sized to provide a minimum of 15 minutes of empty bed contact time (EBCT) across all three vessels at approximately 1.0 MGD with 45% of the

flow diverted through a bypass to reduce TOC to 0.2 mg/L (from a maximum of 2.9 mg/L influent). In this configuration the vessels are in a lead/lag/lag configuration.

c. Other configurations are also available at lower flow rates to optimize the usage of the GAC, maximizing the time between GAC replacement.

d. The system allows for any combination of vessels in any vessel sequence that provides the 15 minutes of EBCT at the given flow rate and produces an effluent with a TOC less than 0.2 mg/L. As such, other vessel configurations are also available at lower flow rates that may not match the lead/lag/lag configuration required at the maximum flow rate but may omit use of one or more vessels to optimize the usage of the GAC, maximizing the time between GAC replacement.

e. Backwashing occurs periodically to "fluff" the vessels to optimize performance of the GAC media and reduce the potential for channeling. Backwashing typically occurs through a timer based on the elapsed time from the last backwash.

f. Refer to strategy in Section 3.41 for the backwashing strategy.

g. Refer also to Section 43 31 13.13.

C. Control Descriptions:

1. The vessels are normally operated in AUTO mode. In this mode, vessel valves are operated by the GAC LCP to put vessels in the specific configuration.
2. Backwashing is initiated upon a timer based on the elapsed time from the last backwash.
3. Refer to GAC Manufacturer O&M.
4. Standard Control Strategies per 40 61 96-3.02: None.
5. Standard Interlocks per 40 61 96-3.01: None.
6. Software Interlocks: None.

D. Local Control:

1. Field:

   Permeate Flow

   Vessel Differential Pressure

   Vessel Inlet Pressure

   Vessel Effluent Turbidity

   Vessel Bypass Flow
2. VFD/MCC: None.

3.41 CONTROL STRATEGY – GAC BACKWASH PUMP

A. Reference Drawings: I-23-101, I-23-102, and I-23-103.

B. Description:

1. The GAC Backwash pumps perform two functions depending on the state of the GAC media. Upon initial fill or when the media is replaced, the GAC backwash pump fluidizes the media bed and removes fines and air from the bed to properly condition the media for operation. Over the lifespan of the GAC media, the GAC Backwash Pump also "fluffs" the media to reduce the potentially for channeling and to address the inherent compaction of the media. This second type of backwash is performed at

a much lower flow rate to minimize the mixing of the different zones in the vessel (spent, adsorption and virgin) that develop.

a. Due to the limited use of the pump, the system consists of a single duty pump.
b. The pump operates against a downstream pressure primarily a result of the water surface elevation of the vessel it services, which is constant.
c. A separate VFD controls the speed of each pump motor to maintain a specified flow rate to a specific pressure vessel during a backwash sequence. The GAC LCP provides the treatment PLC with the specified flow rate.
d. A flow meter, on the piping downstream of the backwash pump, measures the flow rate, which the VFD uses to maintain the flow rate to the vessel.
e. The upstream pressure in the backwash water piping feeding each pump will vary based on the water surface elevation in the finished water tank, which will require an adjustment to pump speed to maintain the specified flow rate as the differential pressure across the pump will not remain constant as water surface elevations vary in the finished water tank.
f. Each pump is sized provide a vessel with backwash water at flow rates between approximately 200 to 700 gpm , allowing a hydraulic loading rate up to 14.0 gpm/ft^2 during the backwash sequence.
g. The pump backwashes a single vessel at a time.

C. Control Descriptions:

1. The pump is normally operated in AUTO mode. In this mode, start/stop and speed is controlled by the PLC to maintain setpoint pressure to a GAC vessel for backwash.
2. The GAC LCP requests start/stop of the pump from the Treatment PLC.
3. Pump speed is independently controlled by the Treatment PLC to control pump flow rate.
4. In the event of utility power failure, pumps will stop due to loss of power. In the event that pumps are operating on standby power and utility power is restored, the pumps will be called to stop when the automatic transfer switch returns to the utility power position. This is required as the transfer switch does not provide for phase synchronized make-before-break transfer from standby to utility power, to prevent motor generated back-EMF from tripping circuit breakers.
5. Pumps will restart on standby or return to utility power in the same mode, number of pumps, and speeds as they were running before. Pumps will be delay-started by the PLC, however. The Pump will be restarted 5 seconds after power availability,
6. Setpoints:

GAC LCP – Backwash Flow Setpoint	700.0 gpm default, range TBD gpm to 700.0 gpm adjustable

7. Standard Control Strategies per 40 61 96-3.02:

   CS3 - PROCESS ALARM(S), SELF-RESETTING - LOW LOW SUCTION (FW) TANK LEVEL

   CS15 - GENERAL PROCESS CONTROL FUNCTION (ANALOG) SYSTEM

   CS61 – VARIABLE FREQUENCY DRIVE SPEED
8. Standard Interlocks per 40 61 96-3.01:

   I1 – MOTOR PROTECTION

I3 – HIGH MOTOR TEMPERATURE

9. Software Interlocks: None.

D. Local Control:

1. Field:
   Suction Pressure
   Discharge Pressure
2. VFD/MCC:
   VFD Keypad
   HAND-OFF-AUTO selector
   VFD SPEED potentiometer
   RUN pilot
   VFD FAULT pilot
   HIGH MOTOR TEMPERATURE pilot
   ELAPSED TIME HOURS indicator
   RESET pushbutton

3.50 CONTROL STRATEGY – CHLORINE GAS DOSING

A. Reference Drawings: I-24-101; -102; and -103, I-30-101.

B. Description:

1. This process provides chlorine solution upstream of the Finished Water Reservoir for the purposes of achieving the necessary Chlorine Contact Time prior to distribution and downstream of the Finished Water Reservoir prior to entering distribution to adjust the Chlorine dose as need to maintain a minimum residual throughout the system.
   a. The system consists of two chlorinators, each servicing a single dosing point. Each chlorinator meters chlorine gas into separate carrier water lines using an eductor. A dedicated pump for each carrier water line provides the flow to transfer the chlorine gas from the point of injection to the dosing location at the main pipe.
   b. A shared standby pump provides backup for the pumps in the system. Thus, the system has two duty and one standby chlorine solution booster pump.
   c. All pumps are constant speed. The pumps operate against a constant back pressure provided by a pressure sustaining valve located in the carrier water line downstream of the eductor.
   d. The upstream pressure in the finished water piping feeding each pump will vary based on the water surface elevation in the finished water tank, which will slightly change where the pump operates on its curve. The pump is sized and selected to ensure the pump operates within its stable operating range despite these variations in overall pressure across the pump.
   e. A Chlorine containment system houses the two chlorine cylinders, providing additional protection to operators from accidental release of chlorine gas.

C. Control Descriptions:

1. The pumps are normally operated in AUTO mode. In this mode, start/stop is controlled by the Treatment PLC.
2. Both carrier water pumps are started and stopped when Raw Water Pumps are running.
3. The solenoid valve for the Chlorinator for Chorine Contact dosing is opened when the pump dosing upstream of the Finished Water Tank is running.
4. The solenoid valve for the Chlorinator for Distribution dosing is opened when the pump dosing downstream of the Finished Water Tank is running.
5. The Chlorinator for dosing upstream (for Chlorine Contact dosing) of the Finished Water Tank is paced based on GAC discharge flowrate and the chlorine residual set point for chlorine contact.
6. The Chlorinator for dosing downstream (for Distribution dosing) of the Finished Water Tank is paced based on flow rate measured immediately downstream of the branch diverting GAC Backwash water and the chlorine residual set point for maintaining the minimum residual in the distribution system.
7. The Operator selects pump assignment at local SCADA to match discharge valving.
8. In the event of utility power failure, pumps will stop due to loss of power. In the event that pumps are operating on standby power and utility power is restored, the duty will be called to stop when the automatic transfer switch returns to the utility power position.
9. Pumps will restart on standby or return to utility power in the same mode, and number of pumps as they were running before.
10. Setpoints:

Chorine Contact Residual Chlorine Setpoint	1.5 ppm default, range 1.0 to 3.0 adjustable
Distribution residual Chlorine Setpoint	1.5 ppm default, range 1.0 to 3.0 adjustable

11. Standard Control Strategies per 40 61 96-3.02:
    CS15 – GENERAL PROCESS CONTROL FUNCTION (ANALOG) SYSTEM
12. Standard Interlocks per 40 61 96-3.01:
    I1 – MOTOR PROTECTION
    I2 – HIGH DISCHARGE PRESSURE
13. Software Interlocks: None.

D. Local Control:
1. Field:
   Chlorine Cylinder Weight
   Chlorine Leak Detector
   Calibration Column
   Discharge Pressure
2. VFD/MCC:
   HAND-OFF-AUTO selector
   VFD SPEED potentiometer
   RUN pilot
   FAIL pilot

HIGH DISCHARGE PRESSURE pilot

RESET pushbutton

3.51 CONTROL STRATEGY – SODIUM HYDROXIDE DOSING

A. Reference Drawings: I-25-101, I-30-101.

B. Description:

1. This process provides sodium hydroxide to the finished water exiting the Finished Water Reservoir to manage pH control prior to releasing the water to distribution.
    a. The system has one duty and one standby positive displacement pump.
    b. Both pumps draw from a common chemical drum and feed into a common dosing line which doses the solution in the chemical area of the plant.
    c. Each pump operates against a pressure sustaining valve located at the dosing point to provide a constant pressure for the pumps to operate against as well as prevent accidental dosing when the pumps our not operating.
    d. The pumps are driven by a motor capable of operating at variable speeds, controlled by the Membrane LCP.
    e. Each pump operates at a flow rate between 0.01 gpm and 1.2 gpm.

C. Control Descriptions:

1. The pumps are normally operated in AUTO mode. In this mode, start/stop and speed is controlled by the Treatment PLC.
2. Pumps are started and stopped when Raw Water pumps are running, to maintain Treated Water pH.
3. Speed is controlled to maintain Treated Water pH.
4. Pumps alternate upon pump stop.
5. In the event of utility power failure, pumps will stop due to loss of power. In the event that pumps are operating on standby power and utility power is restored, the duty will be called to stop when the automatic transfer switch returns to the utility power position.
6. Pumps will restart on standby or return to utility power in the same mode, number of pumps, and speeds as they were running before.
7. Setpoints:

Treated Water pH Setpoint	7.0 pH default, range 6.5 to 7.5 adjustable

8. Standard Control Strategies per 40 61 96-3.02:
    CS15 – GENERAL PROCESS CONTROL FUNCTION (ANALOG) SYSTEM
    CS51 – ALTERNATION – SOFTWARE
9. Standard Interlocks per 40 61 96-3.01: None.
10. Software Interlocks: None.

D. Local Control:

1. Field:
    Tote Weight

Calibration Column
Discharge Pressure
Discharge Flow

2. VFD/MCC:
   HAND-OFF-AUTO selector
   VFD SPEED potentiometer
   RUN pilot

3.52 CONTROL STRATEGY – BACKWASH COAGULANT DOSING

A. Reference Drawings: I-26-101, I-22-110.

B. Description:
   1. This process provides backwash coagulant to the waste backwash water prior to entering the Plate Settler Tank in Area 70 to condition the backwash water to allow particulates captured by the membrane treatment process, straining process and GAC process in the plant to settle out of the fluid prior to recycling the backwash water to the raw water tank.
      a. The system has one duty and one standby positive displacement pump.
      b. Both pumps draw from a common chemical drum and feed into a common dosing line which doses the solution in the chemical area of the plant.
      c. Each pump operates against a pressure sustaining valve located at the dosing point to provide a constant pressure for the pumps to operate against as well as prevent accidental dosing when the pumps our not operating.
      d. The pumps are driven by a motor capable of operating at variable speeds, controlled by the Membrane LCP.
      e. Each pump operates at a flow rate between 0.01 gpm and 1.2 gpm.

C. Control Descriptions:
   1. The pumps are normally operated in AUTO mode. In this mode, start/stop and speed is controlled by the PLC.
   2. Pumps are started and stopped when one of the Plate Settler Feed Pump is in operation.
   3. Speed is controlled based on the coagulant dosage setpoint.
   4. Pumps alternate upon pump stop.
   5. In the event of utility power failure, pumps will stop due to loss of power. In the event that pumps are operating on standby power and utility power is restored, the duty will be called to stop when the automatic transfer switch returns to the utility power position.
   6. Pumps will restart on standby or return to utility power in the same mode, number of pumps, and speeds as they were running before.
   7. Setpoints:

Coagulant Dosage Setpoint	TBD mg/L default, range TBD to TBD mg/L adjustable*

*Dosage will be set upon selection of Coagulant during commissioning.

8. Standard Control Strategies per 40 61 96-3.02:
   CS15 – GENERAL PROCESS CONTROL FUNCTION (ANALOG) SYSTEM
   CS51 – ALTERNATION – SOFTWARE
9. Standard Interlocks per 40 61 96-3.01: None.
10. Software Interlocks: None.

D. Local Control:
   1. Field:
      Calibration Column
      Discharge Pressure
   2. VFD/MCC:
      HAND-OFF-AUTO selector
      VFD SPEED potentiometer
      RUN pilot

3.53 CONTROL STRATEGY – PLANT WATER PUMPING

A. Reference Drawings: I-26-101.

B. Description:
   1. This process diverts water from the potable water heading to distribution immediately prior to leaving the water treatment plant but after Chlorine and pH adjustment and boosts the pressure for use as potable and utility water in the water treatment plant.
      a. The system consists of two pumps operating in a parallel configuration, both with integral variable frequency drives.
      b. The integral controls maintain pressure at a specified set point by automatically switching the pumps on and off and changing the speed of the pumps in operation. This system is designed to operate the pumps as efficiently as possible with a constant pressure with the minimum number of pumps required.
      c. A pressure sensor downstream of the pumps monitors water consumption in the system and signals to the speed controller to adjust the motor speed up or down.
      d. Pumps alternate to evenly distribute operating hours over time. The pumps alternate automatically, starting the pump with the lowest number of running hours since the power was last turned off.

C. Control Descriptions:
   1. The pumps are normally operated in Local AUTO mode. In this mode, start/stop and speed is controlled by each pump's integral controller/VFD.
   2. Pumps are started and stopped to maintain controller setpoint pressure settings.
   3. Speed is controlled to maintain controller setpoint pressure setting.
   4. Pumps do not automatically alternate, as each has its own controller and pressure setpoints. Assignment of lead/lag pumps is determined by Operator setting of controller setpoints at each pump. The pump with a lower pressure start setpoint will start as lead.

5. In the event of utility power failure, pumps will stop due to loss of power. In the event that pumps are operating on standby power and utility power is restored, the pumps will stop, then restart based on controller pressure settings.
6. Setpoints:

System Pressure Setpoint	35.0 psig default, range 25.0 to 55.0 adjustable

7. Standard Control Strategies per 40 61 96-3.02:
   CS2 – FLOW TOTALIZATION
   CS3 - PROCESS ALARM(S), SELF-RESETTING - LOW PW PRESSURE
   CS19 – DATA ARCHIVING HISTORIAN AND HISTORICAL FUNCTIONS
8. Standard Interlocks per 40 61 96-3.01: None.
9. Software Interlocks: None.

D. Local Control:
   1. Field:
      Discharge Pressure
      Discharge Flow
   2. VFD/MCC:
      SETPOINT INCREASE AND DECREASE pushbuttons
      RUN pilot
      VFD FAULT pilot

3.54 CONTROL STRATEGY – FINISHED WATER RESERVOIR

A. Reference Drawings: I-30-101.

B. Description:
   1. This process provides storage for the LeChee PS No. 3 and the future Upper Antelope PS, but primarily serves as a reservoir to obtain the required chlorine contact time prior to entering the distribution system.
      a. The maximum allowable pressure of the membrane modules and the required transmembrane pressure across the membrane limit the maximum water surface elevation in the finished water tank as flow rates exceed 400.0 gpm in the plant (based on a maximum allowable pressure of 55 psig and a required transmembrane pressure of 35.0 psig).
      b. The minimum volume in the tank required to obtain the minimum amount of detention required to achieve the chlorine contact time limits the minimum water surface elevation in the tank. A stand pipe on the tank discharge ensures the process provides the minimum amount of contact time required to satisfy disinfection requirements.
      c. Within these limits, the set points of the finished water reservoir are based on the community demands and ensuring there is adequate space to operate continuously (but not necessarily at a constant flow rate) over the duration the plant operates during the day.

d. Due to the varying demands and large size of the reservoir, the elevation in the tank must also take into consideration the water age in the tank as a high water surface elevation under very low community demands will significantly increase water age, leading to the additional formation of DBPs due to extensive detention time in the reservoir.

C. Control Descriptions:

1. The FW Tank level is forwarded from the WTP Telemetry PLC to the LeChee PS No. 3 Telemetry PLC via radio.
2. Setpoints:

WTP - FW Tank High High Level Alarm Setpoint	30.5 ft (4351.3 ft EL) default, range 16.5 ft (4337.1 ft EL) to 31.2 ft (4351.8 ft EL) adjustable
WTP - FW Tank Low Low Level Alarm Setpoint	8.0 ft (4328.6 ft EL) default, range 6.0 ft (4326.6 ft EL) to 10.0 ft (4330.6 ft EL) adjustable

3. Standard Control Strategies per 40 61 96-3.02:

   CS24 - DATA TRANSFER REQUIREMENTS BETWEEN THE PLC's AND THE SCADA SYSTEM
4. Standard Interlocks per 40 61 96-3.01: None.
5. Software Interlocks: None.

D. Local Control:

1. Field:

   Finished Water Flow

   Finished Water pH

   Finished Water Chlorine Residual

   Reservoir Level
2. VFD/MCC: None.

3.60 DECANT PUMP SYSTEM

A. Reference Drawings: I-40-104

B. Description:

1. This system removes decanted water from the solids drying beds during a recant and drying process and transfers the decanted water to a retainment pond nearby.
2. Two constant speed Decant Water Pumps in a duty/standby configuration regulate water surface elevation in the Solids Decant Water Vault.

C. Control Descriptions:

1. The pumps are normally operated in AUTO mode. In this mode, start/stop is controlled by the Treatment PLC.
2. Pumps are started and stopped to maintain/in response to level setpoints.
3. Pumps alternate upon pump stop.
4. Setpoints:

5.

High High Level Setpoint	6.0 ft (4308.8 ft EL)
Start Level Setpoint	4.5 ft (4307.3 ft EL) default, range 3.0 ft (4305.8 ft EL) to 5.0 ft (4307.8 ft EL) adjustable
Stop Level Setpoint	2.0 ft (4304.8 ft EL) default, range 1.0 ft (4303.8 ft EL) to 2.5 ft (4305.3 ft EL) adjustable

6. Standard Control Strategies per 40 61 96-3.02:
   CS2 – FLOW TOTALIZATION
   CS11 – GENERAL READY, RUNNING AND FAILURE SYSTEM
   CS19 – DATA ARCHIVING HISTORIAN AND HISTORICAL FUNCTIONS
   CS51 – ALTERNATION – SOFTWARE
7. Standard Interlocks per 40 61 96-3.01:
   I1 – MOTOR PROTECTION
   I3 – HIGH MOTOR TEMPERATURE
   I10 – HIGH MOISTURE
8. Software Interlocks: None.

D. Local Control:
   1. Field:
      Tank Level
   2. VFD/MCC:
      HAND-OFF-AUTO selector
      RUN pilot
      VFD FAULT pilot
      HIGH MOTOR TEMPERATURE pilot
      HIGH MOISTURE PRESSURE pilot
      ELAPSED TIME HOURS indicator
      RESET pushbutton

3.61 CONTROL STRATEGY – SOLIDS EQUALIZATION SYSTEM

A. Reference Drawings: I-70-101; -104.

B. Description:
   1. The Solids Equalization System collects and equalizes waste backwash water from backwash processes occurring in the water treatment plant as part of the Membrane Treatment Process, the Raw Water Strainers and the media bed conditioning ("fluffing") sequence for the GAC Vessels.
   2. The system consists of an equalization tank, two submersible pumps used to transfer the equalized backwash water to the Plate Settler Tank and provide the recirculation flow in the tank, two control valves to distribute flow to the Plate Settler Tank and back into the Solids Equalization Tank, and a diffuser used to evenly circulate the backwash water returned to the tank from the pump.
   3. The Solids Equalization Tank has a capacity of up to approximately 6000 gallons and can accommodate depths of up to 8.0 ft.

a. The treatment PLC monitors the following operations at the plant during operation:
    1) The flow meter downstream of the membrane backwash pumps and the duration of the pump operation during the backwash sequence.
    2) The flow meter at the membrane valve rack for the treatment train in backwash (during the forward flush step of the membrane backwash sequence) and the duration of the forward flush step.
    3) The duration of the backwash sequence for a raw water strainer (the Treatment PLC uses a flow rate established and set during commissioning to define the flow rate of the waste backwash water).
b. The Treatment PLC primarily uses this information to establish a time averaged flow rate entering the Solids Equalization Tank for the purpose of managing the water surface elevation in the tank as specified in the Treatment PLC.
c. The Treatment PLC will also modify the water surface elevation prior to the initiation of a media bed conditioning ("fluffing") sequence for the GAC Vessels. Prior to starting the sequence, the depth in the Solids Equalization Tank will be reduced within a specified time period to accommodate the additional backwash water entering the tank during this process. The PLC monitors the following operation at the plant to establish the total volume of water discharged into the tank during the process.
    1) The flow meter immediately downstream of the GAC System Waste Backwash Water discharge point and the duration of pump operation during the sequence.
    2) The water surface elevation in the Solids Equalization Tank.
d. The Treatment PLC primarily uses this information when determining the target flow rate transferred to the Plate Settler Tank after the sequence is completed to match the measured water surface elevation in the tank to the average water surface elevation in the basin as specified in the Treatment PLC back with a specified time period.

4. Two constant speed Plate Settler Feed Pumps in a duty/standby configuration regulate water surface elevation in the Solids Equalization Tank, recirculate waste backwash water to keep solids suspended, and transfer waste backwash water to the Plate Settler Tank for further treatment.
    a. Each pump operates against two control valves located in the Solids Valve and Meter Vault, which distribute flow to the Plate Settler Tank and back into the Solids Equalization Tank while providing a constant back pressure in which to keep the pump operating in the stable region of the pump curve.
5. One control valve is located on the piping used to transfer the waste backwash water in the Solids Equalization Tank to the Plate Settler Tank for further processing.
    a. The Treatment PLC uses the data provided by the flow meter immediately upstream of the control valve and modulates the control valve to match the time averaged flow rate established from the incoming flows into the tank.
    b. When the Settled Backwash Solids Pump in the Plate Settler Tank is turned on, the Treatment PLC uses the data provided by the flow meter immediately downstream of this control valve and modules the control valve to match the combined flow rate of the time averaged flow rate established from the incoming flow into the basin and the flow rate measured by the flow meter downstream of

the Settled Backwash Solids Pump in the Solids Valve and Meter Vault, thus maintaining a constant water surface elevation in the Plate Settler Basin.

6. The other control valve is located on the piping used to return remaining flow pumped by the Plate Settler Feed Pumps that is not transferred to the Plate Settler Tank.
   a. The control valve is open when a Plate Settler Feed Pump is on, closed when both a Plate Settler Feed Pump and Settled Backwash Solids Pump are on, and closed otherwise.
   b. During commissioning, the flow meter immediately upstream of this valve is used to set the maximum open position of the valve, which will provide the appropriate back pressure required to operate the Plate Settler Feed Pump operating in the stable region of its curve.

C. Control Descriptions:
   1. The pumps are normally operated in AUTO mode. In this mode, start/stop is controlled by the Treatment PLC.
   2. Pumps are started when plant is operating.
   3. Pumps alternate upon pump stop.
   4. Setpoints:

High High Level Setpoint	10.0 ft (4311.7 ft EL)
Target Level Setpoint (Operating)	8.0 ft (4309.7 ft EL) default, range 7.0 ft (4307.7 ft EL) to 9.0 ft (4310.7 ft EL) adjustable
Target Level Setpoint (GAC Conditioning)	4.0 ft (4305.7 ft EL) default, range 2.0 ft (4303.7 ft EL) to 5.0 ft (4306.7 ft EL) adjustable
Equilibrium Time (After GAC Conditioning)	2 hours

   5. Standard Control Strategies per 40 61 96-3.02:
      CS2 – FLOW TOTALIZATION
      CS11 – GENERAL READY, RUNNING AND FAILURE SYSTEM
      CS19 – DATA ARCHIVING HISTORIAN AND HISTORICAL FUNCTIONS
      CS51 – ALTERNATION – SOFTWARE
   6. Standard Interlocks per 40 61 96-3.01:
      I1 – MOTOR PROTECTION
      I3 – HIGH MOTOR TEMPERATURE
      I10 – HIGH MOISTURE
   7. Software Interlocks: None.

D. Local Control:
   1. Field:
      Tank Level
   2. VFD/MCC:
      HAND-OFF-AUTO selector
      RUN pilot
      VFD FAULT pilot

HIGH MOTOR TEMPERATURE pilot
HIGH MOISTURE PRESSURE pilot
ELAPSED TIME HOURS indicator
RESET pushbutton

3.62 CONTROL STRATEGY – PLATE SETTLER SYSTEM

A. Reference Drawings: I-70-102; -104.

B. Description:
   1. The Plate Settler System provides a quiescent zone along with the added settling capacity from a high efficiency sedimentation plate pack to remove solids from the waste backwash water using coagulation and sedimentation prior to recycling the settled backwash water to the Raw Water Tank.
   2. The system consists of a tank, a high efficiency plate settler assembly, two submersible pumps used to periodically transfer settled solids from the tank to the solids drying bed, a flow meter, a manual control valve, and a diffuser used to evenly distribute the flow into the basin from the Solids Equalization Tank and maintain a quiescent area upstream of the plate pack.
   3. The Plate Settler Tank has a capacity of up to approximately 5400 gallons and can accommodate depths of up to 8.0 feet
      a. During normal operation, the elevation in the Plate Settler Tank is entirely controlled by the weirs immediately upstream of the effluent trough. The plate settler equipment is oversized, making changes in the tank elevation over the range of flow coming from the Solids Equalization Tank very small.
      b. During a solids removal process, the additional flow transferred to the Plate Settler Tank accommodates the volume removed by the Settled Backwash Solids Pumps while still providing a continuous flow across the plate settler equipment equivalent to that occurring during normal operation.
   4. Two constant speed Settled Backwash Solids Pumps in a duty/standby configuration removed settled backwash solids from the Plate Settler Tank when operating.
      a. Each pump operates against a manual control valves located in the Solids Valve and Meter Vault, which provides a constant back pressure in which to keep the pump operating in the stable region of the pump curve.
   5. The control valve is located on the piping used to transfer the settled backwash solids to the solids drying beds.
      a. The control valve is manually set during commissioning to provide the appropriate amount of headloss needed to keep the pump in the stable region of the pump curve and provide consistent flow.
      b. Treatment PLC uses the data provided by the flow meter immediately upstream of the control valve to measure the flow rate exiting the Plate Settler Tank to the solids drying bed. It uses this information to adjust the Plate Settler Feed Pump to maintain a constant waters surface elevation in the Plate Settler Tank during a solids removal sequence.
      c.

C. Control Descriptions:

1. The pumps are normally operated in AUTO mode. In this mode, start/stop is controlled by the Treatment PLC.
2. Pumps are started and stopped based on timer.
3. Pumps alternate upon pump stop.
4. Standard Control Strategies per 40 61 96-3.02:
   CS2 – FLOW TOTALIZATION
   CS11 – GENERAL READY, RUNNING AND FAILURE SYSTEM
   CS19 – DATA ARCHIVING HISTORIAN AND HISTORICAL FUNCTIONS
   CS51 – ALTERNATION – SOFTWARE
5. Standard Interlocks per 40 61 96-3.01:
   I1 – MOTOR PROTECTION
   I3 – HIGH MOTOR TEMPERATURE
   I10 – HIGH MOISTURE
6. Software Interlocks: None.

D. Local Control:
1. Field:
   Tank Level
2. VFD/MCC:
   HAND-OFF-AUTO selector
   RUN pilot
   VFD FAULT pilot
   HIGH MOTOR TEMPERATURE pilot
   HIGH MOISTURE PRESSURE pilot
   ELAPSED TIME HOURS indicator
   RESET pushbutton

3.63 CONTROL STRATEGY – SETTLED BACKWASH WATER SYSTEM

A. Reference Drawings: I-70-103; -104.

B. Description:
1. The Settled Backwash Water System collects and collects the effluent from the Plate Settler Tank coming off from the trough downstream of the plate settler pack to allow a constant feed of recycled backwash water into the Raw Water Tank and provide a break in the hydraulic profile to allow the plate settler pack to free discharge into the effluent trough and the effluent trough to free discharge into the Settled Backwash Water Tank. It also provides a means in which flow can be returned to the equalization tank for reprocessing should the recycled water quality not meet water quality requirements.
2. The system consists of a tank, two submersible pumps used to transfer the settled backwash water to the Raw Water Tank and provide the recirculation flow in the tank, two control valves to distribute flow to the Raw Water Tank and back into the Settled Backwash Water Tank, and a diffuser used to evenly circulate the settled backwash water returned to the tank from the pump.

3. The Settled Backwash Water Tank has a capacity of up to approximately 1800 gallons and can accommodate depths of up to 6.0 ft.
    a. The Treatment PLC primarily uses the time averaged flow rate used to control the Plate Settler Feed Pumps to maintain the water surface elevation in this tank.
4. Two constant speed Settled Backwash Water Pumps in a duty/standby configuration regulate water surface elevation in the Settled Backwash Water Tank, recirculate settled backwash water to prevent freezing, and transfer settled backwash water to the Raw Water Tank.
    a. Each pump operates against two control valves located in the Solids Valve and Meter Vault, which distribute flow to the raw water tank and back into the Settled Backwash Water Tank while providing a constant back pressure in which to keep the pump operating in the stable region of the pump curve.
5. One control valve is located on the piping used to transfer the settled backwash water in the Settled Backwash Water Tank to the to the Raw Water Tank.
    a. The Treatment PLC uses the data provided by the flow meter immediately upstream of the control valve and modulates the control valve to match the time averaged flow rate established to control the Settled Backwash Water Pump.
6. The other control valve is located on the piping used to return remaining flow pumped by the Settled Backwash Water Pumps that is not transferred to the Raw Water Tank.
    a. During commissioning, the flow meter immediately upstream of this valve is used to position the valve, which will provide the appropriate back pressure required to operate the Settled Backwash Water Pump operating in the stable region of its curve.

C. Control Descriptions:
1. The pumps are normally operated in AUTO mode. In this mode, start/stop is controlled by the Treatment PLC.
2. Pumps are started when plant is operating.
3. Pumps alternate upon pump stop.
4. Setpoints:
5.

High High Level Setpoint	7.0 ft (4308.7 ft EL)
Target Level Setpoint (Operating)	6.5 ft (4308.3 ft EL) default, range 4.0 ft (4305.7 ft EL) to 6.5 ft (4308.7 ft EL) adjustable

6. Standard Control Strategies per 40 61 96-3.02:
   CS2 – FLOW TOTALIZATION
   CS11 – GENERAL READY, RUNNING AND FAILURE SYSTEM
   CS19 – DATA ARCHIVING HISTORIAN AND HISTORICAL FUNCTIONS
   CS51 – ALTERNATION – SOFTWARE
7. Standard Interlocks per 40 61 96-3.01:
   I1 – MOTOR PROTECTION
   I3 – HIGH MOTOR TEMPERATURE
   I10 – HIGH MOISTURE

8. Software Interlocks: None.

D. Local Control:
   1. Field:
      Tank Level
   2. VFD/MCC:
      HAND-OFF-AUTO selector
      RUN pilot
      VFD FAULT pilot
      HIGH MOTOR TEMPERATURE pilot
      HIGH MOISTURE PRESSURE pilot
      ELAPSED TIME HOURS indicator
      RESET pushbutton

END OF SECTION

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SECTION 40 62 00

COMPUTER SYSTEM HARDWARE AND ANCILLARIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Operator computer workstations.
   2. Server.
   3. Uninterruptible power systems (UPS).

B. Equipment List:

Item
Plant Operator Workstation 1
Plant Operator Workstation 2
Server 1
Server 2
Workstation 1 UPS
Workstation 2 UPS
Server UPS

1.02 SUBMITTALS

A. The following information shall be provided for the LeChee WTP in accordance with Section 01 33 00:

B. Action Submittals – Product Literature:
   1. A copy of this specification section, and those listed below with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. A copy of the contract document Instrumentation diagram I-00-311 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   3. Refer to Paragraph 2.01 C prior to submittal.
   4. Submit marked product literature for all products per the requirements of Section 40 61 13.

5. List of spare parts to be provided.
6. Copy of NTUA response to RFI for latest hardware configuration required.

C. Action Submittals – Server Rack Shop Drawings and Product Literature:
   1. Submit under Section 40 67 00.
   2. A copy of this specification section, and those listed below with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. A copy of the contract document Electrical and Instrumentation diagrams per Spec. 40 67 00-1.01 C relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   4. Submittal requirements of Section 40 67 00:
      a. Marked product literature.
      b. Dimensioned drawings.
      c. Panel assembly drawings.
      d. Nameplate engraving schedule.

D. Closeout Submittals - Operating and Maintenance Information:
   a. Submit operating and maintenance information for products specified herein in accordance with Section 01 78 23, including the following:
      1) Manufacturer instruction manuals shall include the following:
         a) Safety Precautions.
         b) Environmental Conditions.
         c) Troubleshooting guides and diagnostic techniques.
      2) Warranty information.
      3) Final reviewed action submittals.

1.03 SPECIAL WARRANTY

A. Workstations:
   1. Provide a Manufacturer Support Warranty including 24 hour 7 day telephone and online tech support. Manufacturer shall warrant specified products against defects in materials and workmanship for 3 years.

B. Servers:
   1. Provide a System Support and ztC Edge Services Warranty including 24 hour 7 day telephone and online tech support. Manufacturer shall warrant specified products against defects in materials and workmanship for 3 years.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. The Owner requires the specified manufacturers to provide the equipment and/or products to be furnished under this section. The Owner believes the manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed to mean that the named manufacturer's standard product will comply with the requirements of this Section.

B. Manufacturers and models shall be as specified for the purpose of compatible and efficient utilization of existing equipment, supplies, maintenance contracts, and personnel training and experience, no substitutions are permitted.

C. Manufacturers and models specified are per NTUA at the time of specifying. Models become obsolete, and NTUA preferred manufacturers are subject to change. Initiate request for information (RFI) to confirm manufacturers, part numbers, and features prior to shop drawings submittal.

2.02 COMPUTER WORKSTATIONS (CONTROL ROOM WORKSTATION)

A. Tower Style PC Hardware:
   1. Office grade enclosure.
   2. Intel Xeon W3-2435 3.1 to 4.5 GHz Processor, 8 cores.
   3. 16 GB of DDR5 RAM.
   4. NVIDIA Graphics processor with 4GB RAM, multi-monitor capable.
   5. HDMI video connection capable of 1920 x 1080 resolution or higher.
   6. Two 1TB SATA 3.0Gb/s 7200 RPM hard drives.
      a. RAID 1 mirrored array configuration, factory integrated.
   7. 10/100/1000 Mbps network interface card.
   8. Four USB 3.0 ports.
   9. DVD-RW drive.
   10. Three expansion bays.
   11. 120 Vac.
   12. Microsoft Windows 11 Professional.
   13. Acceptable Manufacturers:
      a. Dell Precision 5860.
      b. Lenovo approved equal.

B. Desktop Monitor:
   1. 27 inch diagonally measured display.
   2. Minimum 2560 x 1440 resolution.

3. HDMI video connection, DVI video connection.
4. LED backlit LCD, 800 to 1 contrast ratio.
5. Maximum sync rate (vertical scan rate x horizontal scan rate): At least 75 Hz x 80 KHz.
6. 170 degree horizontal and vertical viewing angle.
7. Anti-glare.
8. Adjustable tilt, pivot, height, and swivel.
9. 120Vac.

C. Keyboard:
1. Full keyboard including tenkey.
2. Non-wireless.

D. Mouse:
1. Optical.
2. Non-wireless.
3. No trackball.

E. Speakers:
1. Two speakers, no sub-woofer.
2. Non-wireless.
3. Bose.

F. Acceptable Manufacturers, provide all equipment from one of the following:
1. Dell.
2. HP.
3. Lenovo approved equal.

2.03 SERVER HARDWARE

A. Acceptable Manufacturers:
1. Stratus ztC Edge 250i.

B. Server hardware:
1. Form factor: Wall or DIN rail mount.
2. Processor: Intel Xeon processor 1.8 GHz, 20 MB cache, 10 HT cores.
3. Memory: 64 GB, type DDR4 2666 MHz ECC.
4. Internal storage: 2 TB solid state drive (SSD).
5. Operating system:
   a. Microsoft Windows Server 2022 or latest version of Windows server.
   b. Stratus Redundant Linux.
6. Communication ports:
   a. RJ-45, gigabit ethernet ports, auto-sensing 10/100/1000BASE-T.
      1) Two for a-links.
      2) Six for plant networks.

b. Six USB ports.
c. Keyboard port.

7. Provide redundant Server a-link interconnecting cables.
8. Power: 120 VAC, provide adapter.

C. Monitor:
1. 14 inch diagonally measured display.
2. Minimum 1920 x 1080 resolution.
3. HDMI video or DVI video connection.
4. LED backlit LCD.
5. Adjustable tilt.
6. 120Vac.
7. One for use with either server.
8. Acceptable Manufacturers:
a. Dell.

D. Keyboard:
1. Full keyboard including tenkey.
2. Non-wireless.
3. One for use with either server.
4. Acceptable Manufacturers:
a. Dell.

E. Mouse:
1. Optical.
2. Non-wireless.
3. No trackball.
4. One for use with either server.
5. Acceptable Manufacturers:
a. Dell.

2.04 SERVER RACK

A. Server Cabinet:
1. Minimum dimensions: 78”H x 24”W x 35” D.
2. Locking perforated doors, rear door split. Provide side and perforated top panels.
3. Sliding shelves.
4. Panel and rails to mount servers and power supplies.
5. Sliding shelf to hold server monitor, keyboard, and mouse
6. Shelf in bottom for UPS units.
7. Acceptable Manufacturers:
a. nVent/Hoffman ProLine FloTek PC.
b. Rittal equal.

2.05 WORKSTATION SOFTWARE

A. General:
   1. License all software products in the Owner's name. Request licensee name and address from the Construction Manager prior to ordering. Provide latest versions.

B. HMI Software:
   1. Refer to Section 40 68 13.

C. Office Software:
   1. Provide Microsoft Office Professional for each workstation.

2.06 UNINTERRUPTIBLE POWER SYSTEM (UPS)

A. General:
   1. The UPS shall be line interactive, sine wave output.
   2. Provide power monitoring and shutdown software.

B. Ratings:
   1. Nominal input voltage: 120Vac.
   2. Nominal output voltage: 120Vac.
   3. Backup time, minutes: 5.
   4. Power:
      a. Workstations: 1000VA each.
      b. Server: 1.5 KVA. One for both servers.

C. Spare Parts:
   1. Replacement battery for each UPS.

D. Manufacturer:
   1. Schneider Electric/APC, Back-UPS Pro.

PART 3 EXECUTION

3.01 INSTALLATION

A. Software:
   1. Provide the following software pre-loaded by the Server manufacturer:
      a. Operating system.
   2. Install and configure the following software:
      a. Workstation office software.
      b. Server software.
      c. UPS software.

B. Applications Configuration:
   1. Network switch and other devices configuration will be by the Owner. Schedule in advance.

C. UPS:
   1. Provide USB cables between each UPS and workstation/server, length as required.

D. Workstation to Peripherals:
   1. Route and tie cables neatly.

E. All Cybersecurity considerations, configurations, and validations will be provided by the Owner.

3.02 SERVER VIRTUALIZATION

A. Provide the following virtual machines and resource allocations at a minimum for SCADA software to be provided per section 40 68 13:
   1. SCADA domain controller
   2. Application server: 2
   3. Historian

3.03 FIELD QUALITY CONTROL

A. Field test and verify operation in accordance with Section 40 61 21.

B. Troubleshoot and repair any intermittent or inoperative network connections.

3.04 SYSTEMS START UP

A. Procedures: Section 01 45 20 and 01 79 00.

B. Operational testing and commissioning shall be performed and documented as specified and required by Section 01 91 00 and 01 99 90.

END OF SECTION

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SECTION 40 63 43

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope

1. This Section specifies requirements for large programmable logic controllers (PLC) designed to execute discrete and continuous control logic with high reliability in industrial applications. Enclosures and components are specified in Section 40 67 00.
2. The Telemetry PLCs provided for this project shall be as specified per Technical Provisions 4.0, refer to drawings. Provide CAD generated drawings customized for this project based on those examples.
3. The Treatment PLC, MBR and GAC PLCs provided for this project shall comply with the requirements of this Section.
4. The MBR and GAC PLCs provided with equipment specified in Divisions 23, 42, 43, and 46 shall be provided by the Equipment Manufacturer. All other PLCs shall be provided by the Systems Integrator per Section 40 61 13.

B. PLC Schedule:

Panel No.	PLC Size	Testing	Spares
Telemetry PLC – Intake PS	Small		Not required
Telemetry PLC - WTP	Small		Not required
Telemetry PLC – LeChee PS No. 3	Small		Not required
Treatment PLC	Large	Factory Acceptance	Required
MBR PLC	Large		Required
GAC PLC	Large		Required

C. General Requirements

1. General requirements shall be as specified in Sections 40 61 13 and 40 67 00.
2. PLC assemblies provided by Equipment Manufacturers may be provided by firms other than the Systems Integrator.

1.02 QUALITY ASSURANCE

A. References

1. This Section contains references to the following documents or documents listed in Sections 26 05 00, 40 61 13, and 40 67 00. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEC 61131-3	Programmable Controllers – Part 3: Programming Languages
NEMA IA 2.2	Programmable Controllers – Equipment Requirements and Tests
NEMA IA 2.3	Programmable Controllers – Programming Languages

B. Systems Integrator
   1. Responsibilities and qualifications shall be as specified in Section 40 61 13.

C. Factory Acceptance Tests:
   1. Factory Acceptance Tests are specified in Section 40 61 21 and scheduled in paragraph 1.01 PLC Schedule.
      a. Submit factory test forms for approval prior to tests.
      b. Provide all expenses for one Owner staff member and one Engineer staff member to witness factory testing. Travel shall be during business hours on weekdays.

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Sections 01 33 00 and 40 61 13.

B. Provide separate submittals for each of the Intake PS, LeChee WTP, and the LeChee PS No. 3 for the following:

C. Action Submittals - Shop Drawings:
   1. Submit under Section 40 67 00, including:
      a. A copy of this Specification Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification Sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. Submittal requirements per Section 40 67 00 for the equipment specified herein.
   3. LeChee PS No. 3, refer to Paragraph 1.01 A. For other PLCs:
      a. Marked product literature for the components to be provided.
      b. PLC Input/Output (I/O) loop diagram drawings.
      c. Internal power distribution schematic diagram drawings.
      d. PLC power supply loading calculations.
      e. List of spare parts to be provided.

D. Closeout Submittal - Operating and Maintenance Information:
   1. Operating and maintenance information shall be provided in accordance with Section 01 78 23, including the following for the PLC system. Submit under Section 40 67 00:
      a. Manufacturer, Representative, and Supplier contact information.
      b. Manufacturer instruction manuals shall include only the following as applicable to the PLC system:
         1) Safety Precautions.
         2) Environmental Conditions.
         3) Troubleshooting guides and diagnostic techniques.
         4) Component connection diagrams.
         5) Removal and replacement instructions.
      c. Warranty information.
      d. Final reviewed submittal.
      e. As-built drawings with record of switch and jumper settings for all components.
      f. List of spare parts provided.

E. Closeout Submittals - PLC Program. Refer also to Spec. 40 61 13-1.01 B:
   1. Provide the as-built programmable controller program prepared using the software type specified in Part 2.

PART 2 PRODUCTS

2.01 GENERAL

A. Manufacturer:
   1. The Owner and Construction Manager require the specified Manufacturer to provide the equipment and/or products to be furnished under this Section. The Owner and Construction Manager believe the Manufacturer is capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed to mean that the named Manufacturer's standard product will comply with the requirements of this Section.
   2. Manufacturers and models shall be as specified for the purpose of compatible and efficient utilization of existing equipment, supplies, and personnel training and experience, no substitutions are permitted.

B. Materials:
   1. Equipment and/or products shall be new and unused at the time of system assembly.

C. Controller conforming to NEMA IA 2.2, and with required memory and functional capacity to perform specified sequence of operation with scheduled input and output points.
   1. RFI/EMI Susceptibility: MIL STD 461B CS02.
   2. Showering Arc Test: NEMA Pub No ICS2-230.42.
   3. Surge Withstand: ANSI C37.90a.
   4. RFI Immunity: IEC 801-3.
   5. Ground Continuity: IEC 801-5.
   6. Electrostatic Discharge: IEC 801-2.
   7. Electromagnetic Field: IEC 61000-4-3.
   8. Fast transients: IEC 61000-4-4.

2.02 PROGRAMMABLE LOGIC CONTROLLER - LARGE

A. Manufacturer:
   1. Square D Modicon M340 or M580.

B. Not used.

C. NEMA IA 2.3 and IEC 61131-3 compliant program editor with program written in Ladder Logic, or Equipment Manufacturer's standard Language. Program to be written using the same type of software as is specified below.

D. Networking Connections: As shown. Provide all communication interfaces, network cables, taps, terminators, power supplies, and accessories for a complete operating network.
   1. Modbus TCP/IP.
   2. Provide separate network ports for PLC to PLC and for Programming laptop interfaces.
   3. Treatment PLC: Provide additional separate PLC network port for interface to VFDs.

E. Processor:
   1. Serial port dedicated solely for programming use, and battery-backed solid-state RAM memory for storage of the control program. Provide additional serial communications adapters required for other serial interfacing. RAM memory size shall be provided so that 50% is available after program is tested.

F. Not used.

G. Input and Output Modules:
   1. Discrete Inputs: 24 Vdc.
   2. Discrete Outputs: 24 Vdc.
   3. Analog Inputs: 4-20 mAdc/1-5 Vdc, isolated channel-to-channel.
   4. Analog Outputs: 4-20 mAdc, isolated channel-to-channel.
   5. Spare Input/Outputs: The greater of a minimum one channel or 15 percent of each type provided per control panel.
   6. I/O Chassis spare slots: Minimum 2 per chassis.
   7. Manufactured I/O Cables for all modules:
      a. By PLC Manufacturer or other electrical component Manufacturer.
      b. Cable pre-attached to connector compatible with I/O module.
      c. Discrete Input:
         1) Cable with one wire for each I/O module terminal, ready for insertion into separate terminal blocks for field connections.
      d. Discrete Output:
         1) Cable with one wire for each I/O module terminal, ready for insertion into separate terminal blocks for field connections.
      e. Analog Input:
         1) Cable with one wire for each I/O module terminal, ready for insertion into separate terminal blocks for field connections.
      f. Analog Output:
         1) Cable with one wire for each I/O module terminal, ready for insertion into separate terminal blocks for field connections.
      g. Verify cable length required prior to ordering.

H. Power Supplies:
   1. Not used.
   2. Processor and I/O Chassis:
      a. Single, 120 Vac input.
   3. I/O only Chassis: Single, 120 Vac input.

I. Miscellaneous:
   1. Provide all cables, taps, terminators, power supplies, and accessories for a complete operating PLC system.

2.03 PROGRAMMING SOFTWARE

A. The following software shall be provided by the Systems Integrator for this project.

B. Programmable Logic Controller - Large
   1. Manufacturer:
      a. Square D Modicon Unity.
   2. Licenses: Not required.

2.04 SPARE PARTS

A. The following spare parts shall be provided.

B. Programmable Logic Controller - Large
   1. One of each unique processor card.
   2. One of each unique remote I/O and communication card.
   3. One for each ten, minimum of one for each unique I/O card.
   4. One of each unique power supply.
   5. One of each unique pre-fabricated cable.

2.05 CONTROL PANEL FABRICATION

A. Refer to Section 40 67 00.

B. Detail shop drawings showing field connections and any terminal block jumpering required.

C. Terminate all used and spare I/O wiring to terminal blocks.

D. Create wire markers with “to-from” component name, PLC slot/base, or terminal column number and terminal number information identical at each end. [For Large PLC I/O Cables, the cable bundle shall also be labeled with “to-from” PLC slot number and terminal column number information identical at each end.]

E. Provide terminal Blocks for field connections to PLC Discrete Inputs:
   1. One fused terminal with LED for each group of 8 inputs, connected to control power.
   2. Fused terminal connected to eight terminal blocks to provide power to each field input circuit.
   3. One terminal per PLC input.
   4. One common terminal for each group of 8 inputs, connected to control power common.
   5. Surge protecting terminals for each outdoor mounted instrument or equipment input signal, grounded to the frame ground bus.

F. Provide terminal Blocks for field connections to PLC Discrete Outputs:
   1. One fused terminal with LED for each output, connected to control power.
   2. Provide interposing relay for each solid-state PLC output. Connect output and control power common to relay coil. Provide two terminals for relay contact, normally opened unless otherwise noted.
   3. One common terminal for each output, connected to control power common.

G. Provide terminal Blocks for field connections to PLC Analog Inputs:
   1. One fused terminal with LED for each input, connected to +24 Vdc.
   2. Two terminals per PLC input.
   3. One common terminal for each input, connected to 24 Vdc common.
   4. One ground terminal for each input shield, connected to signal ground bus.
   5. Two surge protecting terminals for each outdoor mounted instrument or equipment, grounded to the frame ground bus.

H. Provide terminal Blocks for field connections to PLC Analog Outputs:
   1. One fused terminal with LED for each output, connected to +24 Vdc.
   2. Two terminals per PLC output.
   3. One common terminal for each output, connected to 24 Vdc common.
   4. One ground terminal for each output shield, connected to signal ground bus.
   5. Two surge protecting terminals for outdoor mounted equipment, grounded to the frame ground bus.

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to Section 40 67 00.

B. Connect input and output devices to the PLC via control panel terminal blocks, not directly to the PLC.

3.02 FIELD INSPECTION AND TESTING

A. Refer to Section 40 67 00.

B. Equipment Manufacturer and Systems Integrator: The supplier of each PLC system shall provide a qualified service representative to perform the following:
   1. Inspect the PLC installation including I/O and network systems, hardware configuration switch and jumper settings.
   2. Monitor all PLC system diagnostic indicators, both hardware and software, and certify that the PLC system performance meets or exceeds the Manufacturer's published specifications.
   3. Assist in all testing.
      a. The Systems Integrator will provide a minimum of:
         1) Ffour man-weeks on-site for each the Intake PS Telemetry PLC.
         2) Four man-weeks on-site for the WTP Telemtry PLC.
         3) Six man-weeks on-site for the WTP Treatment PLC
         4) Two man-weeks on-site for the LeChee PS No. 3 Telemetry PLC.
         5) Equipment Manufacturer shall provide a minimum of eight man-weeks on-site for the MBR and GAC PLCs.
   4. Modify PLC programs as required.

5. Certify in writing to the Construction Manager that the PLC system has been installed and configured in accordance with the Manufacturer's published guidelines. Equipment Manufacturer certification requirements are per the associated equipment Specification.

C. Contractor

1. Fault or trouble conditions shall be investigated and resolved by the Contractor to the satisfaction of the PLC supplier.

3.03 TRAINING

A. Operations and Troubleshooting

1. The Systems Integrator shall conduct application program maintenance, modification, and re-loading training conforming to the requirements of Section 01 79 00. A minimum of four man-hours on-site including training materials and expenses shall be provided for three maintenance personnel.
2. Equipment Manufacturer training is per the associated equipment Specification.

END OF SECTION

SECTION 40 66 13

SWITCHES AND ROUTERS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies Plant Control System and SCADA System data communication network equipment, and configuration verification and validation including performance testing with certified testing equipment.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
EIA	Electronics Industries Alliance
TIA	Telecommunications Industry Association
NEC	National Electrical Code
NESC	National Electrical Safety Code

1.03 SUBMITTALS

A. The following information shall be submitted in accordance with Section 01 33 00

B. Provide submittal for the LeChee WTP for the following:

C. Action Submittals - Shop Drawings:
   1. Submit under Section 40 67 00, including:

2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review. A copy of Specification Sections 01 11 80 and 01 73 24, with addendum updates included, with each paragraph check-marked to indicate specification compliance. Failure to a copy of the marked-up specification sections shall be cause for rejection of the entire submittal with no further review.
3. A copy of the following Contract Documents' Instrumentation Drawing I-00-311, with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "NO CHANGES REQUIRED." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
4. Marked product literature for the components to be provided.
5. List of spare parts to be provided.
6. Copy of NTUA response to RFI for latest hardware configuration required.

D. Closeout Submittal - Operating and Maintenance Information:
   1. Operating and maintenance information shall be provided under Section 40 67 00.
      a. Include written record of Managed Switch configuration.
      b. List of spare parts provided.

1.04 PROJECT / SITE CONDITIONS

A. The equipment shall be designed and manufactured to meet the specified requirements of Section 01 11 80 and 01 73 24 for environmental and seismic conditions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Owner requires the specified manufacturers to provide the equipment and/or products to be furnished under this section. The Owner believes the manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed to mean that the named manufacturer's standard product will comply with the requirements of this Section.

B. Manufacturers and models shall be as specified for the purpose of compatible and efficient utilization of existing equipment, supplies, maintenance contracts, and personnel training and experience, no substitutions are permitted.

C. Manufacturers and models specified are per NTUA at the time of specifying. Models become obsolete, and NTUA preferred manufacturers are subject to change. Initiate request for information (RFI) to confirm manufacturers and part numbers prior to shop drawings submittal.

D. Candidate manufacturers include:
   1. Cisco Catalyst 3850 or C9300X.

2.02 PRODUCTS

A. Industrial Unmanaged Ethernet Switch:
   1. DIN rail mounted
   2. 8 10/100 BASE-TX twisted pair ports (RJ-45)
   3. Automatic data speed detection
   4. MODBUS TCP/IP support
   5. Auto-crossing function
   6. Quality of Service prioritization of automation protocols.
   7. Power: 24Vdc
   8. Candidate manufacturers:
      a. Phoenix Contact FL 1016N.

B. Industrial Managed Ethernet Switch:
   1. Rack mounted
   2. 12 10/100/1000 BASE-TX twisted pair ports (RJ-45)
   3. Rapid Spanning Tree Protocol (RSTP)
   4. IGMP (Internet Group Management Protocol) support for IP multicast filtering to enable switches to automatically route messages only to appropriate ports
   5. Virtual cable test (VCT) utility
   6. MODBUS TCP/IP support
   7. SNMP and Web based monitoring
   8. Power: 120Vac
   9. Candidate manufacturers:
      a. Cisco Catalyst 3850 or C9300X.

C. Spare Parts:
   1. One Industrial Unmanaged Ethernet Switch.
   2. One Industrial Managed Ethernet Switch.
      a. Provide switch with as-built configuration.

PART 3 EXECUTION

3.01 GENERAL

A. Configure managed switch as directed by the Owner.

B. Provide record of configuration with the O&M.

3.02 FIELD TESTING

A. The network equipment shall be tested.
   1. Test operation of communication ports.
   2. Test data communication circuit from end-to-end for each link of the network.
   3. Test the performance of the network.

END OF SECTION

SECTION 40 66 56

POINT-TO-POINT RADIO EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This Section specifies requirements for Supervisory Control And Data Acquisition (SCADA) radio communications equipment. Enclosures and components are specified in Section 40 67 00.

B. General Requirements:
   1. General requirements shall be as specified in Sections 40 61 13 and 40 67 00.

C. Radio Path Survey:
   1. A radio path survey was performed during design. Antenna heights and directions are specified on the Drawings.

1.02 QUALITY ASSURANCE

A. References:
   1. Refer to Section 40 61 13.

B. Systems Integrator:
   1. Responsibilities and qualifications shall be as specified in Section 40 61 13.

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Sections 01 33 00 and 40 61 13:

B. Provide separate submittals for each of the Intake PS, LeChee WTP, and the LeChee PS No. 3 for the following:

C. Action Submittals - Shop Drawings:
   1. Submit under Section 40 67 00, including:
      a. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
      b. Submittal requirements per Section 40 67 00 for the equipment specified herein.

D. Closeout Submittal - Operating And Maintenance Information:
   1. Operating and maintenance information shall be provided in accordance with Section 01 78 23, including the following for the communication system:
      a. Manufacturer, Representative, and Supplier contact information.
      b. Manufacturer instruction manuals shall include only the following as applicable to the communication system.
      c. Final reviewed submittal.

PART 2 PRODUCTS

2.01 GENERAL

A. Manufacturer:
   1. The Owner and Construction Manager require the specified Manufacturer to provide the equipment and/or products to be furnished under this Section. The Owner and Construction Manager believe the Manufacturer is capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed to mean that the named Manufacturer's standard product will comply with the requirements of this Section.
   2. Manufacturers and models shall be as specified for the purpose of compatible and efficient utilization of existing equipment, supplies, and personnel training and experience, no substitutions are permitted.

2.02 UNLICENSED SPREAD-SPECTRUM 902-928 MHZ

A. Refer to Technical Provisions 4.0 PLC Control Panel Drawings and Section 40 67 00.

2.03 TRANSMISSION SYSTEM

A. Transmission Line:
   1. Times Microwave LMR-400 with type N connectors.
   2. Lightning Protector:
      a. Refer to Technical Provisions 4.0 PLC Control Panel Drawings and Section 40 67 00.

B. Omni-Directional Antenna:
   1. Antenna, omni-directional: Kathrein SCALA K7515641, 5 db.

C. Directional Antenna:
   1. Kathrein SCALA TY-900, 10 dB Yagi.

PART 3 EXECUTION

3.01 INSTALLATION

A. Enclosure:
   1. Refer to Section 40 67 00.

B. Transmission Line:
   1. Route transmission line in conduit to protect from damage. Conduit sweeps shall be long radius bends and fittings shall not cause Manufacturer bend radius limits to be exceeded. Kinked line shall be replaced or a Manufacturer approved splice unit provided to remove the damaged section. Transition from outdoor conduit or pole to antenna shall be provided with a “CGB” weatherproof cord grip, weather-heads not permitted.
   2. Install connectors per Manufacturer instructions. Connection installation shall be witnessed by the Construction Manager. Install weatherproof cold shrink or 3M 2212 rubber tape after connection to antenna or other outdoor component.
   3. Provide ground connection from ground grid / UFER to lightning protector, minimum #4 AWG.

C. Antenna:
   1. Align antennas as specified on Drawings.

3.02 FIELD INSPECTION AND TESTING

A. Refer to Sections 40 61 21 and 40 67 00.

B. Systems Integrator:
   1. Inspect the installation including transmission line and antenna installation, and radio/modem configuration, switch, and jumper settings.

2. Use manufacturer diagnostic software to verify performance, and certify that the communication system performance meets or exceeds the Manufacturer's published specifications. Provide software for your configuration and diagnostics use if the Owner has their own copy. Perform Voltage Standing Wave Ratio (VSWR) tests, and troubleshoot readings of 2:1 ratio or higher and resolve.
3. Assist in all testing. The Systems Integrator will provide a minimum of twelve hours on-site for LeChee PS No. 3 radio and eight hours on-site for each radio at other sites.

C. Contractor:
1. Transmission line or antenna related fault or trouble conditions shall be investigated and resolved by the Contractor to the satisfaction of the Systems Integrator.
2. The Contractor shall replace damaged transmission line or related components, lightning protectors, or connectors that were installed improperly. Re-align antennas as required for maximum signal strength.

END OF SECTION

SECTION 40 67 00

CONTROL SYSTEM EQUIPMENT PANELS AND RACKS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section specifies requirements for panels and cabinets for control equipment for the Intake PS, LeChee WTP, and LeChee PS No. 3.
2. Provide the instrument, control, and monitoring features indicated on the P&ID and electrical drawings. Panels shall be arranged to separate control and instrument devices from power wiring. Panels shall be arranged for dedicated field wiring terminations rated for 600 Vac or less for power, control, and instrument signal wiring, in accordance with NEC Article 409.
3. Vendor and Manufacturer panels specification Sections are referenced in the Panel Schedule and specify additional requirements for these panels.

B. Panel Design:

1. Control Power Distribution:
   a. Panel containing 120-volt powered equipment shall use the din-rail power distribution method with fuses and blown fuse indication. Power is restricted to 120 Vac and 24 Vdc, 12 Vdc for radio equipment.
2. Panels containing voltages greater than 480 Vac shall be separated from the control section by physical barrier.
3. Power Supplies:
   a. Panel containing direct current powered instruments or serving as the termination point for transmission loop powered field instruments shall contain direct current power supply system as specified herein.
4. Electrical Control Devices:
   a. Pushbuttons, indicating lights, relays, and similar equipment located in panels specified in this section shall comply with the requirements of Section 26 09 16.
5. Uninterruptible Power Supplies:
   a. Panel mounted 120 Vac input and 120 Vac output are specified herein.

C. Control Panel Schedule:

Panel No.	Spec	Feature*	Enclosure Type	Short Circuit Current Rating	Panel Title	E-Dwgs / Notes
Telemetry PLC – Intake PS	Technical Provisions 4.0 PLC Control Panel Drawings – Booster with BoosterPAQ	C, 1, 2	NEMA 12	12,000	Telemetry PLC – Intake PS	E-103, I-001
PLC-1000	Technical Provisions 4.0 AC Tank Control Panel Drawings	C, 1, 2	NEMA 12	12,000	Telemetry PLC – LeChee WTP	E-00-131, E-00-511, I-00-301, I-00-311, I-10-101,
Telemetry PLC – LeChee PS No. 3	Technical Provisions 4.0 PLC Control Panel Drawings – Booster with BoosterPAQ	C, 1, 2	NEMA 12	12,000	Telemetry PLC – LeChee PS No. 3	E-102, I-001
RTU-001	40 67 00, 40 66 13	C	NEMA 12	12,000	Network Cabinet	E-00-131, E-00-511, I-00-311
SCADA Cabinet	40 67 00	C	NEMA 12	12,000	SCADA Cabinet	E-102, I-001; E-00-511, I-00-301
PLC-2100	40 67 00	C, 1, 5	NEMA 4X SS	12,000	Treatment PLC	E-00-131, E-00-512, E-00-513. I-00-101, I-00-311, I-10-101, I-21-101, I23-101 through I-70-104 Provide separate PLC Ethernet port and unmanaged Ethernet Switch for interface to VFDs, refer to Section 40 66 13.
LCP-2200	46 61 33	V, 1, 2, 5	NEMA 4X SS	12,000	Membrane Bioreactor (MBR) LCP	E-00-131, E-00-514, -515. I-00-311, I-22 series P&IDs
LCP-2300	43 31 13.13	V, 1, 2	NEMA 4X SS	12,000	Granular Activated Carbon (GAC) LCP	E-00-131, E-00-513, E-00-514. I-00-311, I-23-101, -102, -103.
LCP-2410	40 67 00	C, 3	NEMA 4X Non-metallic	12,000	Chlorine Alarm Panel	E-00-525, E-00-516, I-24-101.
N/A	40 62 00	C	NEMA 1	N/A UPS plug into wall, server and peripherals plug into UPS	Server Rack	E-00-321, I-00-311

**FEATURES Legend*

V - Vendor / Manufacture Panel per equipment specification requirements*

C - Contractor Custom Panel as shown*

1. *Programmable Logic Controller (PLC) or Remote I/O devices
2. *Panel mounted Operator Interface Station (OIS)
3. *Hardwired control logic required
4. *Windowed outer door and inner door for displays or devices.

5. *UPS
6. *Fans
7. *Heating
8. *Air Conditioning
9. *Sun/Rain Hood

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents that are part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid or on the effective date of the Agreement if there were no Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
EIA RS-310C	Racks, Panels, and Associated Equipment
NEMA 250	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508A	Industrial Control Panels
UL 698A	Industrial Control Panels Relating to Hazardous (Classified) Locations
NFPA 79	Electrical Standard for Industrial Machinery
NFPA 70	National Electrical Code (NEC)
NEMA ICS 6	Industrial Control and Systems: Enclosures
ANSI/UL 497-1995	Standard for Protectors for Paired Conductor Communications Circuits
UL 1012	Power Supplies
EIA RS-310C	Racks, Panels, and Associated Equipment
UL 1449	UL Standard for Safety for Surge Protective Devices

B. Listed Products:

1. Equipment and components shall be Underwriters Laboratory (UL) listed for the purpose or UL recognized.
2. The control panels shall be fabricated by a UL-508A recognized facility and shall bear the appropriate UL 508A Industrial Control Panel labels.
3. All panels shall be labeled in accordance with NEC Article 409.

C. Factory Testing:
   1. Prior to shipment, the manufacturer shall test the functional operation of the control panel as described in the control description Section 40 61 96.
   2. Factory Acceptance Tests per Spec. 40 63 43-1.01 and Section 40 61 21.

1.03 SUBMITTALS

A. Submittals shall be provided as specified in Section 40 61 13.

B. Provide separate submittals for each of the Intake PS, LeChee WTP, and the LeChee PS No. 3 for the following:

C. Action Submittals – Shop Drawings:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Owners Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
      a. A marked copy of specification Section 40 61 13.
      b. A marked copy of specification Section 40 61 21.
      c. A marked copy of applicable paragraphs of specification Section 40 61 96.
      d. A marked copy of specification Section 01 45 20.
   2. A copy of the contract document Process and Instrumentation diagrams per Paragraph 1.01 C relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   3. A copy of the contract document Electrical and Instrumentation diagrams per Paragraph 1.01 C relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

4. For Telemetry PLCs, a copy of the contract document Technical Provisions 4.0 drawings per Paragraph 1.01 C relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
5. For the SCADA Cabinet, refer to Paragraph 2.14 prior to submittal.
6. Marked product literature of all the enclosure electrical devices and components mounted on or within the control panel.
7. Submittal requirements of Section 26 09 16.
8. Submittal requirements of Section 40 63 43.
9. Submittal requirements of Section 40 66 56.
10. List of miscellaneous items, cables, and spare parts to be provided.
11. Dimensioned drawings:
    a. Exterior panel and layout
    b. Interior devices and layout
    c. Door-in-door construction devices, where required
12. Panel assembly drawings including sections showing clearances between face and rear mounted equipment.
13. Nameplate engraving schedule:
    a. Indicate engraving by line
    b. Character size
    c. Nameplate size
    d. Panel and equipment tag number and description
14. Wiring drawings:
    a. Schematic diagrams for power.
        1) Loop diagrams for field signal connections to PLC.

D. Informational Submittal – Factory Acceptance Test Schedule And Forms:
    1. Submit under Section 40 61 21 and per the requirements of this Section.

E. Informational Submittal – Installation forms per Part 3.

F. Informational Submittal – Training forms per Part 3.

G. Closeout Submittal – Operating and Maintenance Information:
    1. Operating and maintenance information shall be provided in accordance with Section 01 78 23:
        a. Final reviewed submittal.
        b. Manufacturer’s O&M instructions, edited for this project.
        c. Written record of PLC configuration, jumpers, and switch settings for each module.
        d. List of spare parts provided.

H. Closeout Submittals – PLC and HMI Programs:
   1. PLC: Refer to Section 40 61 13.
   2. Provide the as-built HMI program files.

1.04 ENVIRONMENTAL CONDITIONS

A. Refer to Section 40 61 13.

PART 2 PRODUCTS

2.01 FABRICATION

A. General:
   1. Panels shall be designed for the seismic requirements of Section 40 61 13. Structures, equipment, and devices shall be braced to prevent damage from specified forces. Equipment panels shall be capable of operation following a disturbance.
   2. Nameplates with tag number and equipment description shall identify face-mounted instruments. Instruments shall be mounted for access to components and ease of removal. Cutouts for future equipment shall be blanked off with suitable covers. Instrument tag numbers shall be identified on the panel rear.
   3. Face-mounted equipment shall be flush or semi-flush with flat-black escutcheons. Face-mounted instruments that are more than 6 inches deep, weigh more than 10 pounds, or exert more than a 4 ft-lb moment force on the face of the panel shall be supported underneath at the rear by a 1-inch x 1/8-inch thick steel angle.
   4. Panels less than 60 inches high shall be provided with floor stands to raise the top of the panel to 60 inches above the floor or work platform. Panels that weigh less than 100 pounds may be wall mounted.
   5. Panels with specified requirements including stainless steel or aluminum mounting requirements that are indicated on the project drawings or on the project details take precedence over the panel types or panel features indicated herein.

B. Panel (except Telemetry PLC and Cabinets) Layout:
   1. Provide 20 percent spare contiguous sub-panel area for future expansion.
   2. Provide minimum of 20 percent spare terminal blocks, with a minimum of 10 analog, discrete, power.
   3. Provide minimum of 12 inches clear space from the bottom of the panel to the bottom of the subpanel.
   4. Separation between the power components (over 120Vac) and the control / instrument components (120Vac and less) by locating the power components and the control / instrument components in separate sections of the cabinet enclosure.
   5. Power 480 volt cabinet section and the control / instrument cabinet section with separate door handles.
   6. Separation between the 480 volt power components and the control / instrument components using barriers.
   7. External lockable circuit breaker handle for the main panel disconnect if 480 volt powered.
   8. Individual power and control components with internal circuit breakers, as required.

9. Motor controllers, as required by the equipment specifications.
10. Displays on the front door.
11. Face-mounted equipment flush or semi-flush with flat-black escutcheons.
12. Panel inner door contains a copy of the record elementary and wiring diagrams, or reference as allowed per NEC Article 409.
13. Panel inner door contains a drawing holder.
14. Panel drawings enclosed in a transparent, protective jacket.
15. Panel functions as specified.

C. Cabinet Layout:
1. Separation between the power components (over 120Vac) and the control / instrument components (120Vac and less) by locating the power components and the control / instrument components in separate sections of the cabinet enclosure.
2. Individual power and control components with internal circuit breakers, as required.
3. Panel inner door contains a copy of the record elementary and wiring diagrams, or reference as allowed per NEC Article 409.
4. Panel inner door contains a drawing holder.
5. Panel drawings enclosed in a transparent, protective jacket.
6. Panel functions as specified.

D. Enclosures:
1. Panel enclosures shall comply with the requirements of NEC Article 409 and NEMA 250.
2. Manufacturer:
a. Hoffmann Enclosures, Inc.
b. Rittal.
c. or equal.

E. Products:
1. The specified candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. The manufacturer's standard product may require modification to conform to specified requirements.
2. If only one manufacturer is specified, this is for the purpose of standardization, commonality of spare parts, and Owner experience and training.

2.02 NOT USED

2.03 NOT USED

2.04 NAMEPLATES

A. External door-mounted components and the panel description shall be identified with plastic nameplates. Refer to Section 40 61 13.

B. Machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

C. The nameplates shall be attached to the panel with a minimum of two self-tapping 316 stainless steel screws. Provide RTV sealant for nameplates for NEMA-4X panels.

D. The nameplate wording may be changed without additional cost or time prior to commencement of engraving. Submit nameplate legend with the panel submittal.

2.05 PANEL FEATURES

A. Interconnection Wiring: Panel Interconnecting Wiring:
   1. Panel control wiring: Single conductor stranded copper NEC rated Type MTW No. 16 AWG minimum(rated 10 A per NFPA 79, Table 12.5.1), with an exception for factory supplied PLC wiring harnesses that are U.L. approved.
   2. Panel instrument wiring: Twisted No. 16 AWG shielded pair or tri conductors.
   3. Panel power wiring: Conductors specified in Division 26 and meet the NEC requirements for power including phase, grounded, and grounding conductors.
   4. Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame retardant plastic wiring channels.
   5. Wiring channels shall comply with UL 94, Type V.
   6. Plastic wireway with covers shall be used to route groups of wires. Wireway fill shall be sized to provide 50% maximum fill.
   7. Plastic spiral wrap shall be used for exposed wires. Wires that cross door hinges shall be enclosed in plastic spiral wrap.

B. Conductor Identification:
   1. Wiring shall be tagged at every termination with machine printed plastic sleeves or pre-printed self-sticking labels as manufactured by W.H. Brady, 3M, or approved equal. No hand-written labels are permitted.
   2. Three-part wire numbers for instrument and control panel internal conductors:
      a. Part-1: Prefix of the wire number shall be the instrument loop number or equipment tag number.
      b. Part-2: Code letter and wire colors per the following tables.
      c. Part-3: Number that identifies individual circuit conductor Terminal Number.

Code	120 Vac Conductor	Color
L	Power	Black
C	Control	Red
N	Neutral	White
PG	Ground	Green

Code	V dc Conductor	Color
PS	24 Vdc Power	Violet
PS	24 Vdc Control	Blue
PS	DC Common	Brown
S+	Signal (+)	White
SG	Signal Ground	Black
EG	Equipment Ground	Green
FV	Panel Foreign Voltage	Yellow

C. Conductor Installation and Protection:
   1. Power and control wiring shall be carried in covered channels separate from low voltage signal circuits. An interior steel barrier shall be provided between AC control devices and the electronic equipment.
   2. Terminal blocks shall be strap screw type rated for 600 volts. Each terminal trip shall have a unique identifying alphanumeric code at one end and a vinyl-marking strip running the entire length of the terminal strip with a unique number for each terminal. Numbers shall be machine printed and 1/8 inch high.
   3. No more than two connections shall be made to one terminal.
   4. Wire connectors shall be locking fork tongue or ring tongue insulated crimp type terminals.
   5. Terminal blocks shall be;
      a. Phoenix Contact or equal products.

D. Field Wiring:
   1. Field wiring shall be connected to separate dedicated terminal blocks in a dedicated part of the panel where the field cables enter the panel. Provide a dedicated raceway on the field side of the terminal block for field wiring use only.

E. Fuse And Fuse Holders:
   1. Fuses for 120 Vac circuits shall have a minimum of 12,000-amperes interrupting capacity and blown fuse indicators.
   2. Fuses for 24 Vdc circuits shall be fast acting glass tube type rated 1/8 or 1/10 amp for 4-20 mA loops.
   3. Fuses for 24 Vdc circuits shall be 1/2 amp for the power supply to individual instruments.
   4. Fuse holders shall be tip-out or draw-out type.
   5. Provide Phoenix Contact or equal products.

F. Control Power:
   1. 120 Vac control power source: Single power source for all control and DC power.
      a. Provide direct current power supplies, as required for the load.
      b. Provide UPS for PLC and derived loop power as specified in Paragraph 1.01, as required for the load.

G. Panel Power: Panel power source (except Telemetry PLC and Cabinets):
   1. Provide a 120 Vac circuit for the panel light and receptacle.

H. Accessories:
   1. Panels (except Telemetry PLCs, Chlorine Alarm Panel, and Cabinets) shall include GFCI convenience receptacles and LED utility lights.
   2. Receptacles and utility lights shall not be powered by the UPS, where included.
   3. Print pocket.
   4. Fold-up shelf of sufficient size, sufficient weight capacity, and the proper angle for supporting a laptop computer mounted to the inside of the enclosure (except Telemetry PLC and Cabinets).

5. Panels (except Telemetry PLCs, Chlorine Alarm Panel, and Cabinets) shall include external access port including GFCI 15 amp duplex 120Vac receptacle and RJ-45 network connection
6. Treatment PLC shall include unmanaged industrial Ethernet Switch, Phoenix Contact or equal.

I. Fail-Safe Wiring (except Telemetry PLC and Cabinets):
1. Fail-safe wiring of control relay or other on/off device or instrument provides the condition that will occur upon loss-of-power or internal failure in the device such that the relay is de-energized in the failure or loss-of-power condition such that the control relay contact operation provides for equipment failing in a safe mode.

2.06 ALARM AND TROUBLE DETECTION

A. The equipment control system shall incorporate a non-energized, open-state, output contact to activate on an alarm or trouble condition or on loss-of-power. Detection of a critical alarm or trouble condition shall cause the control system to initiate the shutdown or the operation of the equipment's controlled components to achieve a "Fail-Safe" condition.

B. Devices that signal an alarm or a trouble conditions shall latch in the alarm position and require a manual reset at the equipment control panel.

C. Alarm and trouble output shall:
1. Open an output dry-contact.
2. Remain open until manually reset.
3. Not indicate abnormal condition when the equipment shutdown manually or automatically.
4. Indicate the alarm at the equipment control panel.

D. Fail-Safe Design and Operation:
1. Failure of part of a system shall not result in the failure of the rest of the system.
2. Failure of equipment or process shall not propagate beyond the failing device or equipment component.
3. Control design and operation shall prevent improper system functioning due to a circuit malfunction or operator error.
4. Control system design shall cause the controlled equipment to operate in a safe mode in the event of loss-of-power or the failure of a control system component.

2.07 CONTROL DEVICES

A. Control devices shall comply with Section 26 09 16.

B. Human machine interface (HMI) touchscreen: Schneider Electric Magelis.

2.08 INDICATING LIGHTS

A. Indicating lights shall be equipped with colored lenses as specified in Section 26 09 16.

2.09 POWER SUPPLY AND CONDITIONING EQUIPMENT

A. Except for power supply units which form an integral part of an individual piece of equipment, all power supply and conditioning equipment shall comply with UL 1012 and shall be approved by UL, CSA, or FM for the application.

B. All power supply equipment shall be provided in redundant configurations such that failure of a single unit will not disable all or any part of the instrumentation and communication systems.

C. Direct-Current Power Supplies (except Telemetry PLC and Cabinets):
   1. Redundancy step-diode isolation shall be provided for redundant direct current supply units and the power supply negative output terminal shall be grounded. Shall be Phoenix Contact, Model STEP-DIODE/5-24DC/2X5/1X10 or equal.
   2. Nominal 24-volt direct-current instrumentation and control power supply:
      a. Convection-cooled linear type or switching type.
      b. Line regulation: 0.4 percent for line variations from 105 to 132 volts
      c. Load regulation: 0.4 percent for load variations from 0 to full load.
      d. Ripple and noise: Not exceed 100 mV peak-to-peak.
      e. Hold-up time at maximum load: Not less than 16 milliseconds.
      f. Continuous duty from 0 to 50 degrees C at rated load.
      g. Output electronically current limited.
      h. Over-voltage crowbar shutdown.
      i. Output voltage:
         1) Rated 28 Vdc
         2) Adjustable plus or minus 5 percent
         3) Set to provide 26.4 volts to the panel direct current bus.
      j. Power Supply: TDK-Lambda, or equal.
      k. Provide dry contact for failure alarm. Dry contact to be wired as an input to the PLC.

D. Uninterruptible Power System (UPS):
   1. The UPS shall be on-line, computer-grade, double conversion type, with electrical isolation including output neutral. UPS shall be packaged for panel enclosure mounting using a back-panel bracket or holder:
      a. Nominal input voltage: 120Vac.
      b. Nominal output voltage: 120Vac.
   2. The online UPS system shall be provided with integral sealed no maintenance batteries, sized to provide full capacity backup power for 10 minute minimum at connected load with integral battery charger.
   3. The panel supplier shall calculate the required kVA rating at 150 percent of connected load. Submit load calculations, schematic diagrams, and wiring connection diagrams. Provide battery cabling and other required cabling for a complete system.
   4. The UPS shall be mounted within the panel on a pedestal or tray with legs to provide space for wire entry and passage.

5. Uninterruptible power supply systems shall be as manufactured by Best Power Technology, Inc., Necedah, American Power Conversion, Wisconsin, or equal.

2.10 SURGE PROTECTION

A. General: Surge protection shall be provided to protect the electronic instrumentation systems from surges propagating along the signal and power supply lines. The protection systems shall be such that the protection level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level, be maintenance free, and self restoring.

B. Surge protectors shall be listed per UL. Surge protectors shall be removable without changing the impedance of the circuit. Surge protectors product manufactures shall be:
   1. AC power lines shall comply with all requirements of UL1449 3rd edition with listed devices having a minimum 18kA surge protection and RFI filtering.
      a. MTL MA30
      b. Joslyn Model 1663-08
      c. Taylor 1020FA
      d. Phoenix Contact
      e. Telematic
      f. Edco
      g. Liebert
      h. Powerware
      i. Or equal.
   2. For analog signal lines use ANSI/UL497 listed device with minimum 15kA protection SD Series, as manufactured by MTL, or approved equal.
   3. For Ethernet BaseT communications use UL497A & UL497B listed ZoneBarrier Model ZB24540IE, Category 6 Universal LAN Protector as manufactured by MTL, or approved equal.

2.11 PANEL GROUNDING

A. Each panel shall be provided with two copper ground bars (except Telemetry PLC and Cabinets).
   1. One bar (NEC required) shall be bonded to the panel or panel frame or back-plate and to the facility grounding system.
   2. Second (signal) ground bar shall be mounted on insulated stand-offs and shall be bonded to the panel ground bar only at one point.

B. Signal circuits, signal cable shields, and low-voltage DC power supply commons shall be bonded to the signal ground bar.

C. Field analog wiring shields shall only be grounded at the signal ground bar. Test to verify that single ground point at panel signal ground bar.

D. Surge protectors and separately derived AC power supplies shall be bonded to the frame ground bar.

E. Panels exceeding 36-inches width shall contain ground bars shall be 1/4- by 1-inch copper bars extending the entire length of the panel interior at the bottom of the panel.

2.12 PANEL DRAWING PROTECTION

A. Provide wiring diagrams in accordance with Section 01 33 00. Provide a panel-wiring diagram and schematic for each panel in a plastic bag or plastic container to avoid water damage and aging.

2.13 NETWORK CABINET

A. Provide freestanding gasketed, pad-lockable cabinet with power distribution and Ethernet Switch specified in Section 40 66 13.

2.14 SCADA CABINET

A. Configuration below is as provided by NTUA in February of 2023 for a separate Dilkon Pass project, subject to change. Initiate request for information (RFI) to confirm part numbers prior to shop drawings submittal.
   1. Fiber Optic Switch: Provide Ciena Z33 Model 3928. NTUA furnished, install and provide connections.
   2. Managed Ethernet Switch: Siemens Rugged-Com RX1501-L3-RM-HI-L3SECL3HW-FG52-CG01-6TX01-6TX01-6TX01-XX-XX, 6GK6015-0BM23-0DC0-Z A03+B36+C02+D01+E01+F01+G00. Provide two: 6GK6000-8FB51-0AA0. (NTUA to confirm)
   3. Power supply: Phoenix Contact QUINT4-PS/1AC/24DC/10, 2904601.
   4. Batteries, C&D Technologies TEL 12-105FNS.
   5. Provide power distribution surge protective device, fuses, circuit breakers, terminal blocks, receptacle, ground bar, wireway, and wiring.
   6. Provide CAT6 cables as required.
   7. Freestanding pad-lockable NEMA 4 Cabinet, front and rear access, air conditioner, Sun West Engineering Z-5G-LTE-SM-MO1734.
   8. Provide the above completely assembled, with interconnecting Ethernet cables and power connections. Generate layout drawings per paragraph 1.01 B. and submit.

2.15 SPARE PARTS

A. The following spare parts shall be provided (except Telemetry PLC and Cabinets):
   1. Ten each of each type of light bulb used in the panels.
   2. Five each of each type and rating of fuse used in the panels.
   3. One each of each type primary protector surge suppressor used in the panels.
   4. Two each of each type of surge protective device used in the panels.
   5. Unmanaged Ethernet Switch.

PART 3 EXECUTION

3.01 GENERAL

A. Floor mounted cabinets shall be mounted and shimmed to precise alignment so doors operate without binding. Sealant shall be provided for conduit entering the panels.

B. Floor-mounted panels except in dry control rooms or electrical equipment rooms shall be mounted on 3-1/2-inch minimum height concrete pads or grouted bases as specified. Coating shall be provided for outdoor panels in contact on concrete. Field panels and cabinets shall be mounted in compliance with Section 40 61 13-3.01.B Field Equipment.

C. Terminals and terminal blocks (except Telemetry PLC and Cabinets) shall be sprayed after all terminations have been completed with a silicone resin conformal coating, Fine-L-Coat Type SR, Dow Corning, or equal.

D. Provide panels with the as-built schematic and connection diagrams located in a print pocket on the inside of the door. Place documentation in a waterproof clear bag in the panel document holder.

E. Verify that all panels have been labeled with Arc Flash warning labels per NEC 110.16. Provide labels, with Arc Flash protection boundary and PPE levels, in accordance with Section 26 05 74.

3.02 MOUNTING

A. Control panels supported directly by concrete or concrete block walls shall be spaced out not less than 5/8 inch by framing channel between instrument and wall. Sills shall be leveled so panel structures will not be distorted. Panels shall be shimmed to precise alignment so doors operate without binding and mounted where shock or vibration will impair its operation.

B. Support systems shall not be attached to handrails, process piping or mechanical equipment. Control panels supported directly by concrete or concrete block walls shall be spaced out from the wall to provide for air circulation around the panels.

C. Steel used for support of equipment shall be 316 stainless steel. Support systems including panels shall be designed to prevent deformation greater than 1/8 inch under the attached equipment load and an external load of 200 pounds in any direction.

D. Floor-mounted cabinets, except in dry control rooms or electrical equipment rooms, shall be mounted on 3-1/2-inch minimum height concrete pads or grouted bases as specified.

E. Panels shall be shimmed to precise alignment so doors operate without binding. Sealant shall be provided under panels not located in dry control or electrical equipment rooms.

F. Center-line of wall-mounted panels shall be 48 inches above the floor.

G. Panel tops of wall-mounted panels shall be mounted at the same elevation.

3.03 PANEL POWER SUPPLY

A. Final raceway connections shall be a flexible conduit in compliance with Division 26.

3.04 FACTORY TESTING

A. The control panel shall be assembled, interconnected, and functionally tested at the assembly shop prior to shipment. The Owner/Engineer shall have the option of witnessing the functional shop test. The Contractor shall notify the Owner/Engineer at least two (2) weeks in advance prior of the scheduled functional shop test.

3.05 FIELD TESTING

A. Field verify the following for Instrument and Control Panels:
   1. Control circuits grounded with one terminal of each load device connected to the grounded conductor.
   2. Control contacts installed in the ungrounded side of the circuit.
   3. Panel signal and control wiring separated and installed in separate wireways with barriers between the power wiring and the signal and control wiring.
   4. Barriers between the power wiring and the signal and control wiring.
   5. Connected to the plant grounding system, as specified.
   6. Inner door contains a copy of the as-built elementary and wiring diagrams, in a protected drawing holder. Drawings shall be enclosed in a transparent, protective jacket.
   7. Panel Functions as specified.
   8. Tested in accordance with Section 26 08 00 and Section 40 61 21.

END OF SECTION

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SECTION 40 68 03

PROCESS CONTROL SOFTWARE COORDINATION AND DOCUMENTATION

PART 1 GENERAL

1.01 DESCRIPTION

A. This section contains requirements for the Contractor and Programmer performance in programming the control systems, progress tracking, testing, and documenting the work for the Plant Control System for the LeChee WTP using the Control Specification – Section 40 61 96.

1.02 QUALITY ASSURANCE

A. Contractor's Programming Manager
   1. The Contractor shall appoint a software engineer or qualified specialist as Programming Manager to manage, coordinate, and supervise the Contractor's programming work.
   2. The Programming Manager shall have at least 5 years of total experience, or experience on at least five separate projects, in managing the programming and startup of similar electrical and instrumentation control systems. The quality assurance program shall include:
      a. Definition of process areas and systems, with programming executed on an area by area basis, based on the P&ID drawings.
      b. Programming for each process area executed in sequential tasks.
      c. Regularly updated programming status tracking by process area, system, and task.
      d. Regularly updated application program software media.

B. Implementation Plan Meetings:
   1. The Systems Integrator shall include as work of this section of the specifications the requirement for two (2) meetings to be held at the project site. The primary function of the meetings shall be to solicit input from the Owner regarding the implementation of the process control system, coordinate SCADA graphic and color presentation, coordinate PLC to PLC and PLC to SCADA network data assignments, and to facilitate preparation of the Process Control System Implementation Plan specified herein.
   2. The Systems Integrator shall have in attendance at each meeting a representative who is responsible for the preparation of the Process Control System Implementation Plan. The preliminary schedule and agenda for each of the meetings shall be as described below. The specific dates for each of the meetings shall be scheduled by the Systems Integrator and approved by the Construction Manager.

3. The Construction Manager shall be provided with two (2) weeks minimum advanced written notice of proposed scheduled meeting dates. The System Integrator shall prepare a detailed meeting agenda and submit it to the Construction Manager with the notice of proposed scheduled meeting dates.
    a. Meeting 1 shall be held within sixty (60) days of receipt of Notice to Proceed. The purpose of this meeting shall be to begin preparation of the Process Control System Implementation Plan. The System Integrator shall be prepared to present the capabilities of the proposed process control system software and the alternatives available for each of the major areas of implementation described by the Process Control System Implementation Plan. This meeting shall also provide details on coordination between SCADA, Telemetry PLC, Treatment PLC, MBR PLC, and GAC LCP programming. If necessary, separate meetings shall be provided for the following:
        1) MBR PLC and Operator Interface programming and coordination per Section 46 61 33.
        2) GAC PLC and any Operator Interface programming and coordination per Section 43 31 13.13.
    b. Meeting 2 shall be held within thirty (30) days of completion of the Engineer's review of the Process Control System Implementation Plan submittal. The purpose of this meeting shall be to discuss the submittal review comments and resolve any related issues.

C. Definitions
1. Control System: Controllers and any associated Operator Interfaces
2. Controller:
    a. Programmable Logic Controller (PLC)
3. Operator Interface:
    a. Plant Operator Workstation, running Operator Interface Station (OIS) software, entire plant.
    b. Human Machine Interface (HMI), for equipment, equipment panel.
    c. Supervisory Control and Data Acquisition (SCADA), for entire plant
4. Process Area: Area comprised of one or more process systems:
5. Process system: Packaged equipment system or subsystem. Refer to P&ID drawings and associated Panels in Section 40 67 00.
6. Input and/or output (I/O) signals:
    a. Physically hard-wired
    b. Via network radio communication.
7. Programming Software: Operating System/Application Manufacturer's software used to program:
    a. Controller
    b. Operator Interface
    c. HMI.
8. Application Software: Operator Interface and/or Computer software used to display the process and alarms, create reports, enable communications, dial-out alarms, or otherwise enhance Operator Interface functionality.

9. Application Programs: Programs created using Programming Software and/or Application Software for control and interface specific to this project.

D. Project Labeling
   1. The items specifying project labeling herein shall include the following as a minimum: Owner's name, facility name, project name, project number, and "Specification 40 68 00."

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Sections 01 33 00 and 40 61 13:
   1. Qualification Submittal
      a. Provide the following submittal in accordance with Section 01 33 00:
         1) Programming Manager Qualifications and resume per paragraph 1.02 Contractor's Programming Manager.
         2) Proposed process area and process system breakdowns.
         3) Example programming status spreadsheet per paragraph 2.02 Programming Documentation.
         4) Example I/O interface summary per paragraph 2.02 I/O Interface Summary.
         5) Initial schedule of operational testing for each process area and system.
         6) Proposed final Application Program Software media type per parargraph 2.03 Application Programs.
   2. Definition Submittal
      a. Provide the following submittal after review of the Qualification Submittal, in accordance with Section 01 33 00-1.01:
         1) A copy of this Specification Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification Sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
         2) A marked copy of specification Section 40 61 21.
         3) A marked copy of specification Section 01 45 20.
         4) A marked copy of specification Section 40 61 96.
         5) Control descriptions per paragraph 2.02 Control Description.
         6) I/O Interface Summaries per paragraph 2.02 I/O Interface Summary.

7) Programming status spreadsheets per paragraph 2.02 Documentation Records.
8) Revised schedule of operational testing for each process area and system.

PART 2 PRODUCTS

2.01 GENERAL

A. The Programming Manager shall provide application programs, documentation, records, and software media as specified in the following paragraphs.

2.02 PROGRAMMING DOCUMENTATION

A. Documentation Records
   1. The Programming Manager shall develop a records keeping system to document progress and completion for each task in each process area or system. The following shall be kept current and available for inspection on-site at all times in a location designated by the Construction Manager:
      a. Programming Manager's qualifications, project programming history, including resume per paragraph 1.02 Contractor's Programming Manager.
      b. List of names of project programmers, and normal and emergency contact telephone numbers
      c. Programming Status spreadsheet with breakdown for each process area and process system, with percentage complete on each programming sequence task.
      d. Programming Documentation Volumes.
      e. Application program media.

B. Documentation Volumes
   1. The Contractor shall develop and maintain programming documentation for each process area in separate volumes. Each volume shall be kept current and available for inspection on-site at all times in a location designated by the Construction Manager. Each volume shall include the following as a minimum:
      a. Three-ring binder with front cover and spine labeled:
      b. "Programming Documentation For (applicable) Process Area / Process System" including Project Labeling per paragraph 1.02 Project Labeling.
      c. Table of Contents with same labeling as the volume cover with tabs for each section:
         1) Section 1 – Control Description
         2) Section 2 – I/O Interface Summary
         3) Section 3 – Control Program
         4) Section 4 – Graphics
         5) Section 5 – Reports

C. Control Description
   1. Provide a control description outlining application program operation for each process area's system. The Control Specification Section 40 61 96 may be used as a basis. Provide details on Operator interaction, manual and automatic mode operation, setpoints, graphic indications, trending, and reports.

D. I/O Interface Summary
   1. Provide I/O spreadsheets [for each process area's system]. Spreadsheets to include the following for each I/O point:
      a. Signal number/tag
      b. Annotation description that may be logically abbreviated and that is subject to approval.
      c. Complete physical I/O channel designation and addressing or communication I/O register designation.
      d. True/False status designations for digital I/O.
      e. Process range; engineering units and any multipliers; and raw signal range count for analog I/O.
      f. Signals: Fixed point and scaled at the Controller with minimum four significant implied digits of scaling. E.g.: 0 to 1400 at Controller for a pH range of 0 to 14 at Operator Interface.
      g. Provide Operator Interface scaling to display decimal digits required.

E. Control Program
   1. Provide Controller program printout with annotation for the I/O, storage registers, results, and functions. Programs to include brief periodic descriptions of process area's system and specific operation performed. Control elements annotated to indicate function, description/tag, range, or other details.

F. Graphics
   1. Graphics shall be provided in P&ID piping format. Provide operator interface system program printouts:
      a. Color prints of each graphic screen
      b. Printout of Graphic I/O and Function Block database, including all data fields available.

G. Reports
   1. Provide printouts of example reports.
   2. Reports to include:
      a. Accumulated total flow for each flow signal at midnight of each day.
      b. Refer to Section 40 61 96.

2.03 SOFTWARE MEDIA

A. Programming Software
   1. Controller and Operator Interface manufacturer's original programming software media and documentation shall be kept complete and on-site.
   2. Upon receipt from the Manufacturer, the warranties and registrations shall be provided to the Construction Manager for completion by the Owner.

B. Application Software
   1. Additional Operator Interface and/or Computer manufacturer's software media and documentation shall be kept complete and on-site.

2. Upon receipt from the Manufacturer, the warranties and registrations shall be provided to the Construction Manager for completion by the Owner.

C. Application Programs
   1. The software application programming shall be kept current on on-site media that shall be CD-ROM, Zip Disk, or Floppy Diskettes as submitted and accepted.
   2. Media shall be permanently labeled “Application Programs For (applicable) Process Area / Process System” including Controller or operator interface manufacturer’s programming software used name; model; and revision/version, and Project Labeling per paragraph 1.02 Project Labeling.

2.04 PRODUCT DATA

A. Software
   1. Programming software, Application software, and Application Program media shall be turned over to the Construction Manager upon completion of the project as a submittal.

PART 3 EXECUTION

3.01 COORDINATION

A. Scheduling
   1. The Programming Manager shall coordinate scheduling and programming activities with the Contractor's Quality Control Manager, specified in Section 01 45 20,
      a. Process area and system schedules shall be coordinated prior to Progress Meetings.
      b. Programming Status spreadsheets shall be presented at Progress Meetings.
      c. No process areas programs will be considered substantially complete until all area programming and related testing activities are determined complete by the Construction Manager.

B. Related Contract Document And Product Submittals
   1. The Contractor shall provide Programming Manager with the referenced and pertinent Specifications and Drawings with Addenda updates marked to indicate submitted and requested deviations from the specified and indicated requirements.
   2. The Contractor shall provide current reviewed product submittals for the instruments, analyzers, VFDs, MCCs, control panels, and vendor or Manufacturer packaged control systems to the Programming Manager.

C. Changes
   1. The Contractor shall provide copies of the pertinent contract correspondence which may effect control system changes to the Programming Manager.
   2. The Programming Manager may request information and clarifications in a Request For Information that is routed through the Contractor.

D. Temporary Facilities
   1. The Contractor shall provide temporary power, network connections, personal communication devices such as radios, work surfaces, and chairs as required for Programmer to insure controller and operator interface readiness prior to Loop Tests and to complete the testing.

3.02 PROGRAMMING EXECUTION

A. Scheduling
   1. The Programming Manager shall coordinate with the Contractor and prioritize programming in the order of process area schedule completion.

B. Sequence Tasks
   1. Programming shall be performed in the following order for each process area:
      a. Control Description approval.
      b. I/O Interface Summary approval.
      c. Program I/O and annotation.
      d. Program controller program.
      e. “Force” or simulate I/O and verify/debug controller program.
      f. Program graphics database.
      g. Program graphics.
      h. “Force” or simulate I/O and verify/debug graphics.
      i. Program and verify/debug reports.

3.03 TESTS

A. The Programming Manager or designated programmer shall witness and assist with Loop Tests, Functional Tests, and Operational Tests outlined in Sections 01 45 20 and 40 61 21.

B. A minimum of 24 man-hours shall be provided per each of the process systems identified in Section 40 61 96. Programming errors noted shall be corrected during tests. Keep on site and submit a log on the request of the Construction Manager for the Tests and man-hours expended.

3.04 TRAINING

1. The Programming Manager shall conduct application program / process operation training conforming to the requirements of Section 01 79 00. A minimum of two, sessions of eight man-hours on-site including training materials and expenses shall be provided , one for each of two shifts of four Operators.
2. The Programming Manager shall conduct application program maintenance, modification, and re-loading training conforming to the requirements of Section 01 79 00. A minimum of four man-hours on-site including training materials and expenses shall be provided for three maintenance personnel.

END OF SECTION

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SECTION 40 68 13

PROCESS CONTROL (OIS) SOFTWARE

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies software systems for the process control system real-time operator interface software (OIS) and historical data management system. The programming and configuration of these software systems shall be performed in accordance with Section 40 68 03.

1.02 SUBMITTALS

A. The following information shall be provided for the LeChee WTP in accordance with Section 01 33 00:

B. Action Submittals – Product Literature:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. Manufacturer's product literature for all software systems, marked to show any options to be provided.
   3. Copy of NTUA response to RFI for latest software configuration required per Paragraph 2.01 B.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. The Owner and Construction Manager require the specified Manufacturer to provide the equipment and/or products to be furnished under this Section. The Owner and Construction Manager believe the Manufacturer is capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed to mean that the named Manufacturer's standard product will comply with the requirements of this Section.

B. Configuration below is subject to change by NTUA and by the Manufacturer. Initiate request for information (RFI) to confirm part numbers and quantities prior to product literature submittal.

C. Manufacturers and models shall be as specified for the purpose of compatible and efficient utilization of existing equipment, supplies, and personnel training and experience, no substitutions are permitted.
   1. Provide the latest release of AVEVA Real-time Human-Machine Interface licenses based on the following part numbers:
      a. Qty 2 each – Intouch HMI Runtime with unlimited tags – Part # Flex-HMI-011.
      b. Qty 2 each – Modbus TCP/IP Communications drivers – Part # Flex COM-001.
   2. Provide the latest release of AVEVA Process Historian Database Server and Clients for trending and data analysis based on the following part numbers:
      a. Qty 1 each – Standard historian, 5,000 tags – Part # Flex HST-001.
      b. Qty 2 each – Historian client concurrent user – Part # Flex HST-004.
   3. Provide the latest release of AVEVA Engineering development Studio:
      a. Qty 1 each – Engineering development studio – Part # Flex -OTH-006.

D. Software shall be provided by the Representative assigned to NTUA:
   1. Q-Mation, Phoenix, AZ.

2.02 SOFTWARE LICENSING AND SUPPORT

A. All process control system software products shall be licensed in the Owner's name and based on the flex subscription pricing model. Subscription term shall be for 3 years and include AVEVA Customer First Standard support, which includes all product upgrades and direct phone support during normal business hours for the term of the contract. The number of licenses for each process control system server application including communication drivers shall be as required to implement the process control system as specified herein and detailed on the Drawings. The number of licenses for process control system client applications shall be as specified in Table 2.02:

Software Application	Number of Licensed Copies	Notes
Process Control System Real-time HMI Data Server, Client and Trending	1	Engineering Development license, includes PLC communications Ethernet driver, and configuration utility for graphics and database development.
Process Control System Real-time HMI Data Server, Client and Trending	2	HMI Client Runtime license, unlimited tags, including communication drivers and client for real-time and historical trending, Excel add-in and query tool for data
Historical Data Management System	1	Process historian based on Microsoft SQL Server Express

PART 3 EXECUTION

3.01 PROCESS CONTROL SOFTWARE SYSTEM PROGRAMMING

A. Process control system software shall be programmed and configured in accordance with the requirements of Section 40 68 03. The software shall be programmed by an AVEVA Certified systems integrator located within 700 miles of the LeChee WTP jobsite. The Systems Integrator programmer shall be listed on the AVEVA Partner website at project bid time.

3.02 TRAINING

A. Contractor shall include as work of this specification the cost of all enrollment fees, round trip air travel, local ground transportation, and lodging for four (4) of the Owner's personnel to attend a 5 day Intouch Comprehensive training course addressing the programming and development of the process control software systems. Training shall be provided in person in Phoenix, Arizona by an AVEVA Certified Training provider.

B. The Contractor shall provide the services of the systems integrator for the purpose of training the Owner's personnel in the proper operation of the process control system graphical operator interface.

C. Training shall address the use of each graphical interface display and the underlying control logic associated with each control and monitoring function as well as the use of all system utilities.

D. Training shall consist of 40 hours of classroom training conducted in two 4-hour sessions per day.

E. Training shall comply with Section 01 79 00 and shall be certified on Form 43 05 11-B specified in Section 01 99 90.

END OF SECTION

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SECTION 40 71 00

FLOW MEASUREMENT

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies requirements for process flow measurement instruments including meters, transmitters, switches, associated indication devices, and accessories

1.02 QUALITY ASSURANCE

A. Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of five years.

B. Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled, Certified Technicians specified in Section 40 61 13, who are regularly engaged in such activities involving systems of similar complexity.

C. References are listed in Section 40 61 13 and are a part of this section as specified and modified.

1.03 ENVIRONMENTAL CONDITIONS

A. Equipment provided under this section shall be suitable for operation under ambient conditions described in Section 40 61 13-1.08.

1.04 SUBMITTALS

A. Submittals:
   1. Procedures: Sections 01 33 00.
   2. Submittal requirements: Section 40 61 13.

B. Provide separate submittals for each of the Intake PS, LeChee WTP, and the LeChee PS No. 3 for the following:

C. Action Submittals – Shop Drawings:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Referenced and applicable sections to be marked up and submitted include:
      a. Section 40 61 13 – Process Control System General Provisions
      b. Section 40 06 70 – Schedules for Instrumentation of Process Systems
         1) Intake PS.
         2) LeChee WTP.
         3) LeChee PS No. 3.

      A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor,

each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. A copy of the following contract document Control Diagrams and Process and Instrumentation Diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
    a. Intake PS: E-100, E-101, E-102, E-103, and E-106.
    b. LeChee WTP: E-00-101, E-00-111, E-00-511 through E-00-516, and all P&IDs with flow instruments.
    c. LeChee PS No. 3: E-101, and E-102.
3. Marked Contract Document Mechanical and/or Electrical Plan drawings, sections, and details showing sensor installation locations and details. Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
4. Marked product literature of all equipment and features to be provided.
    a. Installation drawings for only the transmitters, sensors, and mounting accessories to be provided.
    b. Electrical and signal connection drawings for only the transmitters and sensors to be provided.
5. Not used.
6. Marked product literature for surge protectors.

D. Informational Submittals:
    1. Factory calibration certificates.

E. Closeout Submittals – Operating and Maintenance (O&M):
    1. Include the following in each Operating and maintenance and per Section 01 78 23:
        a. Final Reviewed Submittals.
        b. Manufacturer's O&M instructions, edited for this project.
        c. Record of menu configurations, jumpers, settings (range, set point, deadband) and other configurable parameters for each instrument.
        d. Include list of spare parts and tools provided.

PART 2 PRODUCTS

2.01 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

A. General requirements for instruments specified in this section are specified on the INSTRUSPEC sheets in the Appendix at the end of this section.

B. Application requirements are specified in Section 40 06 70-3.03 – the Instrument Index, and/or on the drawings.

2.02 EQUIPMENT

A. General:
   1. In accordance with Section 01 33 00 the General Conditions of the Contract Documents, drawings, information, and technical data for all equipment as required in Section 40 61 13 and this section shall be provided. All required product data for this section shall be included in one complete package.
   2. The Owner and Construction Manager require the specified Manufacturer to provide the equipment and/or products to be furnished under this Section. The Owner and Construction Manager believe the Manufacturer is capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed to mean that the named Manufacturer's standard product will comply with the requirements of this Section.
   3. Where only one Manufacturer and model is specified, they shall be as specified for the purpose of compatible and efficient utilization of existing equipment, supplies, and personnel training and experience, no substitutions are permitted.

B. Process switch:
   1. Contact outputs used for alarm actuation to be normally-closed or normally-opened as required by the process condition to open to initiate the alarm.
   2. Contact outputs used to control equipment to be normally-opened, and close to start the equipment.
   3. Contacts monitored by solid state equipment such as programmable controllers or annunciators to be hermetically sealed and rated for switching currents from 20 to 100 mA at 24 volts DC.
   4. Contacts, monitored by electromagnetic devices such as mechanical relays, to be rated as NEMA ICS 2, designation B300.
   5. Double barriers provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.
   6. Switch electrical enclosures rated as NEMA 250, Type 4X minimum.
   7. Not used.
   8. Select switch range so that the specified set point is at least 30 percent but not more than 70 percent of the span, between the upper range limit and the lower range limit.

C. Process transmitter:
   1. Not used.
   2. Provide two-wire, three-wire and four-wire transmitters with 4 to 20 milliampere (mA) output signal. Derive operating power for two-wire transmitter from the current output signal. Require an external 24 V DC power supply for three-wire transmitter; the power supply common and the current output return share the same wire. Require an external 24 V DC or 120 V AC power supply for four-wire transmitter; there shall be no electrical connection between the current output signal and the power supply.
   3. Provide load variations within the range of 0 to 500 ohms with the power supply at a nominal 24 volts DC or 120 volts AC with the default range of 0 to 100% corresponding to 4 to 20 mAdc for the transmitter output.

4. Configure transmitter output to increase with increasing measurement except where specified as "reverse action" in the Instrument Index.
5. Provide adjustable time constant from 0.5 to 5.0 seconds for transmitters used for flow, level transmitters used for flow measurement, or pressure measurement.
6. Galvanically isolate via electro-mechanical or optical technology the transmitter output.
7. Provide transmitter enclosures as rated NEMA 250, Type 4X, unless otherwise specified.
8. Surge protect power and output signals for transmitters located outdoors:
    a. Signal: Provide internal surge protector as a product option. If transmitter does not include an internal surge protector then provide an external surge protector: Emerson/Rosemount Model 470 D, Emerson/EDCO SS64-036-2, CCI SPN-42 FS28 Series, or approved equal.
    b. AC Power: Provide internal surge protector as a product option. If transmitter does not include an internal surge protector then provide an external surge protector. External surge protector UL 1449, LED indicator, screw terminal connections, NEMA 4X, EDCO HSP121A or approved equal.
    c. Provide a terminal junction box for housing external surge protector. Box to match NEMA rating of the transmitter.
9. Not used.

2.03 PROCESS PARAMETER OUTPUT INDICATOR - FI

A. Digital LED indicator.
    1. Red Lion PAXI0020, pulse input. Configure for flow rate and total. Provide interposing relay if required between MX 42 pulse output and indicator, refer to paragraph 4.03 FM2.
    2. Red Lion optional 4-20mA analog output module.
    3. NEMA 4 enclosure, minimum 12” x 8” x 6” deep. Nameplate: “PS NO. 3 DISCHARGE FLOW RATE AND TOTAL”.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
    1. Installation requirements specified in Section 40 61 13.

B. Not used.

C. Electrical Connections:
    1. Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of 2 feet.

D. Not used.

3.02 TESTING

A. Testing requirements are specified in Section 40 61 21.

3.04 TRAINING

A. Training requirements are specified in Sections 01 79 00. Provide two training sessions, each with one-half hour for each type of flow measurement instrument.

PART 4 APPENDIX - INSTRUSPECS

4.01 INSTRUSPECS

A. General requirements for instruments specified in this section are listed on INSTRUSPEC sheets herein. Application requirements are specified in the Instrument Index, and/or on the drawings.

INSTRUSPEC Symbol	Instrument description	Instrument function
FM	Magnetic Flow Transmitter	Flow Measurement at WTP
FM2	Magnetic Flow Transmitter - AMI	Flow Measurement at PS No. 3
FTS	Thermal Flow Switch	Flow Measurement

4.02 INSTRUMENT IDENTIFICATION: FM

A. Instrument Function: Flow Measurement.

B. Instrument Description: Magnetic Flow Metering System.

C. Signal Input: Process.

D. Signal Output: Analog signal as specified in paragraph 2.02 and HART.

E. Process Connection: Flange, ANSI B16.5, Class 150 raised face.

F. Product Requirements: Magnetic flow meter provided as a system consisting of a flow tube with converter/indicating transmitter, as scheduled in the Section 40 06 70 Instrument Index, complete with interconnecting cables.
   1. Flow Tube:
      a. Flow tube manufacturer shall provide grounding rings fabricated from the same metal as for the electrodes below.
      b. Electrodes: 316L stainless steel.
      c. Liner: Polyurethane or hard rubber.
      d. National Sanitation Foundation (NSF) certified for water service.
      e. NEMA 6P/IP67 for meters located in vaults.
   2. Remote-mounted indicating transmitter for full-scale flow rates from 1.0 to 30 feet per second. System error shall not exceed the greater of 0.5% of flowrate or 0.1 foot per second from 1.5 to 30 feet per second.

a. Transmitter: Contain electronics associated with the magnetic flow meter system. Enclosure rating NEMA-4, cast aluminum or metal compartment for power, field connections and calibration adjustments separate from digital circuitry.
b. Means to calibrate the metering system without use of external calibration units.
c. Transmitter self-diagnostics.
d. Integral 4-digit LCD flow indication calibrated in process units. Data retained in non-volatile memory.

3. Traceability certificate of actual flow lab certification provided with each flowtube. Calibration for flow range specified in Section 40 06 70 instead of manufacturer's standard range.
4. Manufacturers:
   a. McCrometer Ultra Mag.
   b. Endress + Hauser Promag W400.

G. Execution:
1. Installation: Install in accordance with manufacturer's instructions and the specified functional requirements.
2. Signal cable between the flow tube and transmitter provided by the Manufacturer with sufficient length of cable for continuous installation between the flow tube and the transmitter; no splices.

4.03 INSTRUMENT IDENTIFICATION: FM2

A. Instrument Function: Flow Measurement with AMI.

B. Instrument Description: Magnetic Flow Metering System.

C. Signal Input: Process.

D. Signal Output: Pulse and Sensus Protocol AMI encoder.

E. Process Connection: Flange, ANSI B16.5, Class 150 raised face.

F. Product Requirements: Magnetic flow meter provided as a system consisting of a flow tube with converter/indicating transmitter, as scheduled in the Section 40 06 70 Instrument Index.
1. Flow Tube:
   a. National Sanitation Foundation (NSF) certified.
2. Integral indicating transmitter.
3. Factory certified calibration.
4. Manufacturers:
   a. Honeywell EvoQ4 with replaceable battery, MX42VP Module, EA_Water 3.0 AMI Module. Process indicator per paragraph 2.03.

G. Execution:
1. Installation: Install in accordance with manufacturer's instructions and the specified functional requirements.

4.04 INSTRUMENT IDENTIFICATION: FTS

A. Instrument Description: Thermal Flow Switch

B. Manufacturer:
   1. Fluid Components Inc.
   2. Flow Technology Inc.
   3. Approved equal.

C. Features:
   1. Instrument Function: Flow Measurement
   2. Power Supply: 120 volts AC
   3. Signal Input: Process
   4. Signal Output: Contact as specified in paragraph 2.03.
   5. Process Connection: NPT.
   6. Flow switch shall be the thermal convection type. Switch point shall not be affected by process fluid temperature changes in the range of 32 to 140 degrees F and shall have a repeatability of plus or minus 5 percent of range.
   7. Control unit shall operate with the specified repeatability in an ambient temperature range of 25 to 120 degrees F.

D. Execution:
   1. Installation: Install in accordance with manufacturer's instructions.
   2. Setpoints per Section 40 06 70.

END OF SECTION

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SECTION 40 72 00

LEVEL MEASUREMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies requirements for process level transmitters, associated indication devices, and accessories.

B. This section also specifies requirements for process level activated switches, devices, and accessories.

1.02 QUALITY ASSURANCE

A. Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of five years.

B. Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled, Certified Technicians specified in Section 40 61 13, who are regularly engaged in such activities involving systems of similar complexity.

C. References are listed in Section 40 61 13 and are a part of this section as specified and modified.

1.03 ENVIRONMENTAL CONDITIONS

A. Equipment provided under this section shall be suitable for operation under ambient conditions described in Section 40 61 13-1.08.

1.04 SUBMITTALS

A. Submittals shall be provided as specified in Section 01 33 00 and 40 61 13.

B. Provide separate submittals for each of the Intake PS, LeChee WTP, and LeChee PS No. 3 for the following:

C. Action Submittals - Shop Drawings:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Referenced and applicable sections to be marked up and submitted include:
    a. Section 40 61 13 – Process Control System General Provisions
    b. Section 40 06 70 – Instrument Index

2. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
3. A copy of the following contract document Control Diagrams and Process and Instrumentation Diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
    a. Intake PS: E-100, E-101, E-102, E-103, and E-106.
    b. LeChee WTP: E-00-101, E-00-111, E-00-511 through E-00-516, I-00-101, and all P&IDs with level instruments.
    c. LeChee PS No. 3: E-101.
4. Marked Contract Document Mechanical and/or Electrical Plan drawings, sections, and details showing sensor installation locations and details. Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
5. Marked product literature of all equipment and features to be provided.
    a. Installation drawings for only the transmitters, sensors, and mounting accessories to be provided.
    b. Electrical and signal connection drawings for only the transmitters and sensors to be provided.
6. List of miscellaneous items, cables, spare parts, that will be provided in accordance with INSTRUSPEC sheet requirements.
7. Marked product literature for surge protectors.

D. Informational Submittals.
    1. Test results as specified in Section 40 61 21-2.02.

E. Closeout Submittals - Operating and Maintenance (O&M):
    1. Include the following in each O&M Manual:
        a. Final reviewed submittals.
        b. Manufacturer’s O&M instructions, edited for this project.
        c. Written record of menu configuration, jumpers, switch settings, and other configurable parameters for each instrument.
        d. Include list of spare parts and tools provided.

PART 2 PRODUCTS

2.01 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

A. General requirements for instruments specified in this section are specified on the INSTRUSPEC sheets in the Appendix at the end of this section.

B. Application requirements are specified in Section 40 06 70-3.03 – Instrument Index, and/or on the drawings.

2.02 EQUIPMENT

A. General:
   1. In accordance with Section 01 33 00, the General Conditions of the Contract Documents, drawings, information, and technical data for all equipment as, required in Section 40 61 13 and this section shall be provided. All required product data for this section shall be included in one complete package.
   2. The Owner and Construction Manager require the specified Manufacturer to provide the equipment and/or products to be furnished under this Section. The Owner and Construction Manager believe the Manufacturer is capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed to mean that the named Manufacturer's standard product will comply with the requirements of this Section.
   3. Where only one Manufacturer and model is specified, they shall be as specified for the purpose of compatible and efficient utilization of existing equipment, supplies, and personnel training and experience, no substitutions are permitted.

B. Process switches and devices shall comply with the following requirements:
   1. Contact outputs used for alarm actuation shall be normally-closed or normally-opened as required by the process condition to open to initiate the alarm.
   2. Contact outputs used to control equipment shall be normally-opened and shall close to start the equipment.
   3. Contacts monitored by solid state equipment such as programmable controllers or annunciators shall be hermetically sealed and rated for switching currents from 20 to 100 mA at 24 volts DC.
   4. Contacts, monitored by electromagnetic devices such as mechanical relays, shall be rated as NEMA ICS 2, designation B300.
   5. Double barriers provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.
   6. Switch electrical enclosures rated as NEMA 250, Type 4 minimum.
   7. Not used.
   8. Switch range shall be selected so that the specified set point is at least 30 percent but not more than 70 percent of the span, between the upper range limit and the lower range limit.

C. Measuring elements and transmitters shall comply with the following requirements:
   1. Not used.

2. The two-wire type transmitters shall have operating power derived from the signal transmission circuit.
3. Transmitters shall meet specified performance requirements with load variations within the range of 0 to 600 ohms with the power supply at a nominal 24 volts DC with the default range of 0 to 100% linearly corresponding to 4 to 20 mAdc.
4. Transmitter output shall increase with increasing measurement.
5. Time constant shall be adjustable from 0.5 to 5.0 seconds for transmitters used for flow, level transmitters used for flow measurement, or pressure measurement.
6. Transmitter output shall be galvanically isolated via electro-mechanical or optical technology.
7. Transmitter enclosures shall be rated NEMA 250, Type 4, unless otherwise specified.
8. Transmitters located outdoors shall be provided with surge protectors:
    a. Signal: Emerson/Rosemount Model 470 D, Emerson/EDCO SS64-036-2, CCI SPN-42 FS28 Series, or accepted equal.
    b. AC Power: UL 1449, LED indicator, screw terminal connections, NEMA 4X. EDCO HSP121A or accepted equal.
9. Not used.
10. Not used.

2.03 NOT USED

2.04 NOT USED

2.05 NOT USED

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
    1. General requirements for the installation of primary elements specified in this section are listed on INSTRUSPEC sheets.
    2. Installation requirements are specified in Section 40 61 13-3.01.

B. Not used.

C. Not used.

D. Electrical Connections:
    1. Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of 2 feet.

3.02 TESTING

A. Applicable testing requirements are specified in Section 40 06 70-3.02.

B. Testing requirements are specified in Section 40 61 21.

3.03 NOT USED

3.04 TRAINING

A. Training requirements are specified in Sections 01 79 00. Provide two training sessions, each with one-half hour for each type of level transmitter.

PART 4 APPENDIX - INSTRUSPECS

4.01 INSTRUSPECS

A. General requirements for instruments specified in this section are listed on INSTRUSPEC sheets herein. Application requirements are specified in the Instrument Index, and/or on the drawings.

INSTRUSPEC Symbol	Instrument description	Instrument function
LFS	Float Switch, Free floating	Level Measurement
LFS2	Flood Level Switch	Level Measurement
LGH	Gage Head Level Transmitter	Level Measurement
LUT	Ultrasonic Level Transmitter	Level Measurement

4.02 INSTRUMENT IDENTIFICATION: LFS

A. Instrument Function: Level Measurement

B. Instrument Description: Float Switch, Free-floating

C. Power Supply: N/A

D. Signal Input: Process

E. Signal Output: Contacts, in accordance with paragraph 2.02 of this section.

F. Process Connection: N/A

G. Product:
   1. Switch shall be free-floating type, suspended from an oil resistant waterproof cable. The cable designed to support the weight of the float without additional strain relief and permanently sealed where it enters the float body.
   2. The conductors shall be a minimum size of 18 AWG. The switch shall be a single pole double throw dry contact type and rated at not less than 10 amperes at 120 Vac. Mercury switches are not acceptable. The float shall have a PVC or ABS corrosion and impact resistant shell.

H. Execution:
   1. Installation: Install in accordance with the manufacturer's instructions, Section 40 06 70-3.01, and the specified functional requirements.
   2. Test: In accordance with Section 40 06 70-3.02.
   3. Application/Calibration: In accordance with Section 40 06 70-3.03. Switch set point and reset point adjusted as specified.

I. Approved Manufacturers: Magnetrol model T10, Warrick series M, or equal.

4.03 INSTRUMENT IDENTIFICATION: LFS2

A. Instrument Function: Level Measurement

B. Instrument Description: Flood Level Switch

C. Power Supply: N/A

D. Signal Input: N/A

E. Signal Output: Form C contacts, in accordance with paragraph 2.02 of this section.

F. Process Connection: N/A

G. Product Data:
   1. Float Switch with shield.
   2. NEMA 4X, industrial, protective cage, stainless steel float, magnetic coupling, aluminum switch and terminal housing.
   3. Normally closed, upon up high level.

H. Execution:
   1. Installation: Install in accordance with the manufacturer's instructions, and the specified functional requirements.
   2. Test: In accordance with Section 40 06 70-3.02.
   3. Application/Calibration: In accordance with Section 40 06 70-3.03. Switch set point and reset point adjusted as specified.

I. Approved Manufacturers: Magnetrol FLS.

4.04 INSTRUMENT IDENTIFICATION: LFT

A. Instrument Function: Level Measurement

B. Instrument Description: Differential Pressure/Level Transmitter

C. Power Supply: Loop powered.

D. Signal Input: Process

E. Signal Output: 4-20 mA.

F. Process Connection: NPT.

G. Product: Pressure Transmitter: Capacitance or piezoresistive.
   1. Wetted parts: Type 316 stainless steel or as specified in Section 40 06 70-3.03.
   2. Range: 100:1.
   3. Accuracy: 0.075 percent of calibrated span.

4. Static pressure rating: 2,000 psi.
5. Indicator: LCD display.
6. Not used.
7. Acceptable Manufacturer:
    a. Wika C10.

H. Execution:
1. Installation: Install in accordance with manufacturer's instructions and the Engineer's installation detail.

I. Not used.

J. Not used.

K. Execution:
1. Installation: Install in accordance with manufacturer's instructions as specified on the drawings.
2. Calibration: Differential pressure transmitters in level service on vented tanks:
    a. 0-15 psig range to match or exceed tank height plus elevation below tank to vault connection of up to 32 feet.
    b. 0-30 psig range for taller tanks.
3. Refer to NTUA Technical Provisions W-32.

4.05 INSTRUMENT IDENTIFICATION: LUT

A. Instrument Function: Level Measurement

B. Instrument Description: Ultrasonic Level Transmitter

C. Power Supply: 120 Vac, 60-Hertz nominal

D. Signal Input Process

E. Signal Output: As specified in paragraph 2.02

F. Process Connection: As shown or specified

G. Signal Converter / Indicating Transmitter:
1. Processor: Selectable algorithms for level, volume, or flow.
2. Flow: Parshall Flume, Weir, or configurable flow device.
3. Indicator: 4-digit LCD with 0.50-inch display, scaled in engineering units.
    a. Accuracy: 0.25% of level range.
        1) Analog Outputs: Two 4-20 mA into a minimum of 600 ohms.
        2) Discrete Outputs: Two Form-C rated at 5A, 250 Vac.
    b. Enclosure: NEMA 4 wall mount.

c. Accessories:
    1) Mounting hardware and cable glands.
    2) Removable Handheld infrared programming device – one.
4. Programming software and cable length as required.
5. Not used.
6. Acceptable Manufacturer:
    a. Milltronics Hydroranger 200, XPS-15.
    b. Accepted equal.

H. Sensor:
1. Measuring range: 1 to 33 feet.
2. Beam Angle: 6°.
3. Pressure Limit: 30 psi
4. Temperature Limits: -40 to +175°F.
5. Wetted Materials: PVDF
6. Cable: #16 to #20 TSP with PVC jacket.
7. Maximum Sensor/Transmitter Separation: 1200 ft.
8. Not used.

I. Execution:
1. Installation: Install in accordance with manufacturer's instructions and the Engineer's installation detail.
    a. Contractor to verify size and type of specified tank connection with approved tank submittals.
    b. Transducer rigidly mounted approximately two feet above maximum liquid level and accurately leveled.
    c. Transmitter wall or stand mounted as specified.
    d. Signal cable between the flow tube and transmitter provided by the Manufacturer with sufficient length of cable for continuous installation between the flow tube and the transmitter; no splices.
2. Calibration: In accordance with Section 40 06 70-3.03. Switch set point and reset point adjusted as specified.

END OF SECTION

SECTION 40 73 00

PRESSURE, STRAIN, AND FORCE MEASUREMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies requirements for instrumentation elements that quantitatively convert the measured variable energy into a form suitable for measurement and process measurement accessories. Application requirements are specified in Section 40 06 70.

B. This section specifies requirements for process pressure transmitters, associated indication devices, and accessories.

C. This section specifies requirements for process pressure activated switches, devices, and accessories.

1.02 QUALITY ASSURANCE

A. Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of five years.

B. Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled, Certified Technicians specified in Section 40 61 13, who are regularly engaged in such activities involving systems of similar complexity.

C. References are listed in Section 40 61 13 and are a part of this section as specified and modified.

1.03 ENVIRONMENTAL CONDITIONS

A. Equipment provided under this section shall be suitable for operation under ambient conditions described in Section 40 61 13-1.03.

1.04 SUBMITTALS

A. Submittals shall be provided as specified in Section 40 06 70-1.03.

B. Provide separate submittals for each of the Intake PS and LeChee WTP for the following:

C. Submittals shall be provided as specified in Sections 01 33 00 and 40 61 13, including:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Referenced and applicable sections to be marked up and submitted include:
    a. Section 01 79 00 – Demonstration and Training
    b. Section 01 78 23 – Operating and Maintenance Data
    c. Section 40 61 13 – Process Control System General Provision
    d. Section 40 06 70 – Instrument Index

2. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.

   The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications.

   Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. A copy of the following contract document Control Diagrams and Process and Instrumentation Diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   a. Intake PS: E-100, E-101, E-102, E-103, and E-106.
   b. LeChee WTP: E-00-101, E-00-111, E-00-511 through E-00-516, and all P&IDs with pressure instruments.
4. Marked Contract Document Mechanical and/or Electrical Plan drawings, sections, and details showing sensor installation locations and details. Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
5. Marked product literature of all equipment and features to be provided.
   a. Installation drawings for only the transmitters, sensors, and mounting accessories to be provided.
   b. Electrical and signal connection drawings for only the transmitters and sensors to be provided.
6. List of miscellaneous items, cables, spare parts, that will be provided in accordance with INSTRUSPEC sheet requirements.
7. Marked product literature for surge protectors.

PART 2 PRODUCTS

2.01 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

A. General requirements for instruments specified in this section are specified on the INSTRUSPEC sheets in the Appendix at the end of this section.

B. Application requirements are specified in Section 40 06 70-3.03 – Instrument Index, and/or on the drawings.

2.02 EQUIPMENT

A. General:

1. In accordance with Section 01 33 00 the General Conditions of the Contract Documents, drawings, information, and technical data for all equipment as required in Section 40 61 13 and this section shall be provided. All required product data for this section shall be included in one complete package.
2. The Owner and Construction Manager require the specified Manufacturer to provide the equipment and/or products to be furnished under this Section. The Owner and Construction Manager believe the Manufacturer is capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed to mean that the named Manufacturer's standard product will comply with the requirements of this Section.
3. Where only one Manufacturer and model is specified, they shall be as specified for the purpose of compatible and efficient utilization of existing equipment, supplies, and personnel training and experience, no substitutions are permitted.

B. Process switches and devices shall comply with the following requirements:

1. Contact outputs used for alarm actuation shall be normally-closed or normally-opened as required by the process condition to open to initiate the alarm.
2. Contact outputs used to control equipment shall be normally-opened and shall close to start the equipment.
3. Contacts monitored by solid state equipment such as programmable controllers or annunciators shall be hermetically sealed and rated for switching currents from 20 to 100 mA at 24 volts DC.
4. Contacts, monitored by electromagnetic devices such as mechanical relays, shall be rated as NEMA ICS 2, designation B300.
5. Double barriers provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.
6. Switch electrical enclosures rated as NEMA 250, Type 4 minimum.
7. Switch contacts located in Class I, Division 1 areas and monitored by solid-state circuits shall be made safe by intrinsic safety barriers as specified in Section 40 78 00 01-2.04.
8. Switch range shall be selected so that the specified set point is at least 30 percent but not more than 70 percent of the span, between the upper range limit and the lower range limit.

C. Measuring elements and transmitters shall comply with the following requirements:

1. Measured parameter output indicators complying with paragraph 2.02 shall be provided with any transmitter that does not include an integral indicator. Indicators, whether integral or separate, shall be calibrated in process units, and engraved on the indicator scale plate.
2. The two-wire type transmitters shall have operating power derived from the signal transmission circuit.
3. Transmitters shall meet specified performance requirements with load variations within the range of 0 to 600 ohms with the power supply at a nominal 24 volts DC with the default range of 0 to 100% linearly corresponding to 4 to 20 mAdc.
4. Transmitter output shall increase with increasing measurement.

5. Time constant shall be adjustable from 0.5 to 5.0 seconds for transmitters used for flow, level transmitters used for flow measurement, or pressure measurement.
6. Transmitter output shall be galvanically isolated via electro-mechanical or optical technology.
7. Transmitter enclosures shall be rated NEMA 250, Type 4, unless otherwise specified.
8. Transmitters located outdoors shall be provided with surge protectors:
    a. Signal: Emerson/Rosemount Model 470 D, Emerson/EDCO SS64-036-2, CCI SPN-42 FS28 Series, or accepted equal.
    b. AC Power: UL 1449, LED indicator, screw terminal connections, NEMA 4X. EDCO HSP121A or accepted equal.
9. Two-wire transmitter located in a facility area classified as hazardous per the NFPA and the NEC shall be made safe by means of an intrinsic safety barrier as specified in paragraph 2.04.
10. Four-wire transmitters shall be isolated from the process and power or provided with a loop-powered signal current isolator as specified in paragraph 2.05 connected in the output signal circuit.

2.03 PROCESS PARAMETER OUTPUT INDICATOR

A. Provide digital LED or LCD indicators that integral to the instrument housing where available from the manufacturer. Displays shall be scaled in engineering units, over the calibrated range of the instrument. Calibrate the indicator scale in process units.

B. Analog output indicators shall be 2.5-inch milli-ammeter with 90-degree movement enclosed in a NEMA 7/9 rated meter case. Provide indicators with accuracy within two percent of span. Provide a diode to maintain loop continuity for indicator removal.

2.04 INTRINSIC SAFETY BARRIERS

A. Intrinsic safety barriers for two-wire transmitters shall be of the active, isolating, loop powered type. Barrier shall be Measurement Technology LTD Type MT3042, Stahl Series 9000, Accepted equal.

2.05 SIGNAL CURRENT ISOLATOR

A. Isolator shall provide galvanic isolation of milliampere transmission signals from transmitters. Isolator shall be housed in a NEMA 250, Type 4/7 conduit body and derive operating power from the signal input circuit.

B. Input and output signals shall be 4 to 20 milliamperes, and error shall not exceed 0.1 percent of span. Input resistance shall not exceed 550 ohms with an output load of 250 ohms.

C. Isolator shall be Moore Industries SCX 4-20madc to 4-20madc / 5.5VPL / -RF DIN rail mounted with maximum 250 ohm output impedance, or equal.

2.06 PRODUCT DATA

A. Additional Information: The following product data shall be provided:
   1. Flow calculation for each differential-type flow element.
   2. Record documentation shall include the data sheets specified in this section.

B. The following data provided in accordance with Section 01 33 00:
   1. Operating and maintenance information as specified in Section 40 61 13-2.03. Include final reviewed submittal and separate record of all final configuration, jumper, and switch settings for each instrument.
   2. Test results as specified in Section 40 61 21-2.02.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. General requirements for the installation of primary elements specified in this section are listed on INSTRUSPEC sheets.
   2. Installation requirements are specified in Section 40 61 13-3.01.

B. Process Connections:
   1. General: Unless otherwise specified, process taps shall comply with Section 40 05 01. Process connections shall be arranged such that instruments may be readily removed for maintenance without disruption of process units or draining of large tanks or vessels. Unions or flange connections shall be provided as necessary to permit removal without rotating equipment.
      a. Where process taps are not readily accessible from instrument locations, an isolation valve shall be provided at the instrument.
      b. Isolation valves shall be provided for each instrument where multiple instruments are connected to one process tap.
      c. Pipe between the process connection and instruments shall be 1/2-inch stainless steel with treatment material for easy removal, as specified herein.
   2. Safety Instruments: No valves shall be installed at pressure taps for safety instruments. Safety instruments shall not be connected to the same process tap as instruments used for control, indication, or recording except when annular chemical seals are used.
   3. Root Valves: Root valves shall be provided at all process taps, except as follows:
      a. Temperature taps, where valves are unnecessary.
      b. Pump discharge pressure taps where no instrument is permanently installed. Isolation valves shall be provided.
      c. Process taps for safety instruments.
      d. Where gauge valves are provided.
      e. Where chemical seals are used.
   4. Gauge Valves: Gauge valves shall be provided for each pressure gauge tap except where chemical seals are used.

C. Tubing:

1. Tubing shall be installed on supports spaced not more than 3 feet apart and shall run parallel of perpendicular to walls structural members, or intersections of vertical planes and the ceiling. Unless otherwise shown, tubing shall follow building surfaces closely or shall be carried in trays or conduit.
2. Tubing shall not be supported from piping or equipment except at process taps or connections to the device served. Tubes supported directly on concrete surfaces shall be spaced at least 1/8 inch from the concrete. Tubing support shall be one-hole malleable iron clamps with clamp backs as required. Bends shall be formed to uniform radii without flattening.
3. Ends of tubing shall be square-cut and de-burred before installation in fittings. Fittings shall be used for splices, connections, and turns near final connections. Bulkhead fittings shall be used when tubing enters a panel.

D. Electrical Connections:

1. Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of 2 feet.

3.02 TESTING

A. Applicable testing requirements are specified in Section 40 06 70-3.02.

B. Testing requirements are specified in Section 40 61 21.

3.03 PROCESS CONNECTIONS:

A. Process connection piping and tubing shall be tested in accordance with Section 40 05 01.

3.04 TRAINING

A. Training requirements are specified in Sections 01 79 00. Provide two training sessions, each with one-half hour for each type of level transmitter.

PART 4 APPENDIX - INSTRUSPECS

4.01 INSTRUSPECS

A. General requirements for instruments specified in this section are listed on INSTRUSPEC sheets herein. Application requirements are specified in the Instrument Index, and/or on the drawings.

INSTRUSPEC Symbol	Instrument description	Instrument function
PDHS	Differential Pressure Indicating Switch	Pressure Measurement
PDLS	Differential Pressure Indicating Switch	Pressure Measurement
PDT	Differential Pressure Transmitter	Pressure Measurement
PG	Pressure gage	Pressure measurement
PGT	Gage Pressure Transmitter	Pressure Measurement
PLG	Low range pressure gage	Pressure measurement
PLS	Pressure Switch, Low Range	Pressure Measurement
PS	Pressure Switch	Pressure Measurement

4.02 INSTRUMENT IDENTIFICATION: PDHS

A. Instrument Function: Pressure Measurement

B. Instrument Description: Differential Pressure indicating Switch

C. Power Supply: N/A

D. Signal Input: Process

E. Signal Output: Contacts, in accordance with paragraph 2.02 of this section.

F. Process Connection: 1/4-inch male NPT

G. Product Data:
   1. Gauge: Differential pressure indicating switch shall have a 4-1/2-inch, 210-degree dial face with shatterproof glass window. Bourdon tube shall be bronze unless otherwise specified. Gauges manufactured to Grade A accuracy (±2.5%) in compliance with ANSI specification B40.1. The zero position shall be at the 105-degree point on the dial.
   2. Switch: The number and type of switches as specified in Section 40 06 70-3.03.
   3. The switch points visible on the face of the gauge. The switch set point externally adjustable, using a tamper proof key. The contacts set to open or close at the set point.

H. Execution:
   1. Installation: Install in accordance with manufacturer's instructions, Section 40 06 70-3.01, and the specified functional requirements.
   2. Differential pressure indicating switch mounted on a separate stand and connected to the device using 3/8-inch copper tubing in accordance with Part 3 of this section.

I. Test: In accordance with Section 40 06 70-3.02.

J. Application/Calibration: Application, calibration, and set points as specified in Section 40 06 70-3.03.

K. Approved Manufacturers: Ashcroft Type 1125A with model 2265 electric contact accessory, or equal.

4.03 INSTRUMENT IDENTIFICATION: PDLS

A. Instrument Function: Pressure Measurement

B. Instrument Description: Differential Pressure indicating Switch

C. Power Supply: 120 Vac, 60-Hertz nominal.

D. Signal Input: Process

E. Signal Output: Contacts, in accordance with paragraph 2.02 of this section.

F. Process Connection: 1/8-inch female NPT

G. Product Data:
   1. Indicator: Pressure differential indicator shall have a 4-inch diameter, 90-degree scale. Sensing unit shall consist of two pressure-tight compartments separated by a silicone rubber diaphragm. The diaphragm opposed by a calibrated leaf spring. The motion of the spring transferred to the pointer by magnetic coupling. Bearings shall be sapphire.
   2. Housing material shall be die cast aluminum with a salt resistant coating. Unit capable of withstanding a static working pressures of up to 25 psig. Accuracy shall be plus or minus 2 percent of scale. Zero pointer adjustment accessible from the face.
   3. Switch: Two independently adjustable, photocell-actuated switch circuits provided. The switch circuits actuated by a light shield attached to the indicator pointer. Each switch circuit shall drive a DPDT output relay.
   4. Relay contacts shall be silver cadmium oxide. Switch set points knob-adjustable, accessible from the face and indicated by pointers. Electronic components housed in a translucent styrene acrylonitrile enclosure, mounted on the rear of the indicator.

H. Execution:
   1. Installation: Install in panels specified in Section 26 27 16 in accordance with the manufacturer's instructions, Section 40 06 70-3.01, and the specified functional requirements.
   2. Test: In accordance with Section 40 06 70-3.02.
   3. Application/Calibration: Application, calibration, and set points as specified in Section 40 06 70-3.03.

I. Approved Manufacturers: Dwyer Series 3000 Photohelic, or equal.

4.04 INSTRUMENT IDENTIFICATION: PDT

A. Instrument Function: Pressure Measurement

B. Instrument Description: Differential Pressure Transmitter

C. Power Supply: As specified in paragraph 2.02

D. Signal Input: Process

E. Signal Output: Analog transmission signal as specified in paragraph 2.02

F. Process Connection: Two 1/2-inch female NPT flange adapters

G. Product Requirements:
   1. Pressure Transmitter: Capacitance or piezoresistive type.
   2. Wetted Parts: Type 316 stainless steel or as specified in Section 40 06 70-3.03.
   3. Range: 100:1.
   4. HART standard data communication protocol.
   5. Accuracy: 0.075 percent of calibrated span.
   6. Static Pressure Rating: 2,000 psi
   7. Indicator: LCD display.
   8. Acceptable Manufacturer:
      a. Rosemount 3051CD.
      b. Accepted equal.

H. Execution:
   1. Installation: Install in accordance with manufacturer's instructions and the Engineer's installation detail.
   2. Root valves provided at all process pressure taps.
   3. Gauge valves provided at the instrument where the instrument is not within sight of the root valve or where two or more instruments are connected to a single tap.
   4. Safety instruments shall not be connected to the same process tap as instruments used for control, indication, or recording.
   5. Pressure instruments located as close as practical to the process tap and be positioned to permit observation and maintenance.
   6. Pressure instruments shall not be supported from process piping.
   7. Pressure instruments for use with integral seals, or remote seals and capillary tubing provided by a single manufacturer with components factory-assembled prior to shipping.

I. Seals:
   1. Type: Diaphragm
   2. Process Connection: 3-1/2 inch saddle style, pancake, or flush flanged as required by the application.
   3. Diaphragm and Wetted Parts: Type 316L stainless steel unless otherwise specified in Section 40 06 70.

4. Upper Housing and Mounting Flange: Type 316L stainless steel. Lower Housing: Type 316 stainless steel
5. Temperature Limit, High Side: -40 to 300 degrees F
6. Acceptable Manufacturer:
   a. Rosemount 1199.
   b. Accepted equal.

J. Capillary Option:
1. Seal Location: High pressure side of transmitter, direct mounting
2. Fill Fluid: DC 200 Silicone
3. Capillary Seal Connection Material: Type 316 stainless steel armored sleeving.

4.05 INSTRUMENT IDENTIFICATION: PG

A. Instrument Function: Pressure measurement

B. Instrument Description: Pressure gage

C. Power Supply: N/A

D. Signal Input: N/A

E. Signal Output: N/A

F. Process Connection: 1/2-inch male NPT

G. Product Requirements: Pressure gages shall be 4-1/2-inch premium grade, glycerin filled units with bourdon tube element, 270-degree milled stainless steel movement, phenolic case, and shatterproof glass window. Accuracy shall be 1 percent of span or better. All exposed metal parts shall be stainless steel. Pressure gage manufactures:
1. Ashcroft Duraguage Figure 1279
2. Ametek 1981L
3. or equal.

H. Execution:
1. Installation: Install in accordance with manufacturer's instructions and the recommendations of API RP551 to the specified requirements.

   Root valves shall be provided at all process pressure taps except taps made for safety instruments. Gage valves shall be provided at the instrument where the instrument is not within sight of the root valve or where two or more instruments are connected to a single tap.

   Safety instruments shall not be connected to the same process tap as instruments used for control, indication, or recording. Unless otherwise specified, pressure instruments shall be located as close as practical to the process tap but shall be positioned to permit observation and maintenance. Pressure gages may be supported from the process tap if this location permits observation from the floor or a permanent work platform. Pressure instruments shall be installed in such a manner that blowout discs are not obstructed.

2. Application/Calibration: Application, calibration, and set points shall be as specified in Section 40 06 70-3.03.

4.06 INSTRUMENT IDENTIFICATION: PGT

A. Instrument Function: Pressure Measurement

B. Instrument Description: Gage Pressure Transmitter

C. Power Supply: As specified in paragraph 2.02

D. Signal Input: Process

E. Signal Output: Analog transmission signal as specified in paragraph 2.02

F. Process Connection: 1/2-inch female NPT flange adapter

G. Product Requirements:
   1. Pressure Transmitter: Capacitance or piezoresistive type.
   2. Wetted Parts: Type 316 stainless steel or as specified in Section 40 06 70-3.03.
   3. Range: 100:1.
   4. Accuracy: 0.075 percent of calibrated span.
   5. Static Pressure Rating: 2,000 psi.
   6. Indicator: LCD display.
   7. HART standard data communication protocol
   8. Acceptable Manufacturer:
      a. Rosemount 3051CG.
      b. Accepted equal.

H. Execution:
   1. Installation: Install in accordance with manufacturer's instructions and the Engineer's installation detail.
   2. Root valves provided at all process pressure taps.
   3. Gauge valves provided at the instrument where the instrument is not within sight of the root valve or where two or more instruments are connected to a single tap.
   4. Safety instruments shall not be connected to the same process tap as instruments used for control, indication, or recording.
   5. Pressure instruments located as close as practical to the process tap and be positioned to permit observation and maintenance.
   6. Pressure instruments shall not be supported from process piping.
   7. Pressure instruments for use with integral seals, or remote seals and capillary tubing provided by a single manufacturer, and all components factory-assembled prior to shipping.

I. Seals:
   1. Type: Diaphragm,
   2. Process Connection: 3-1/2 inch saddle style, flush surface or inline style.

3. Diaphragm and Wetted Parts: Type 316L stainless steel unless otherwise specified.
4. Upper Housing and Mounting Flange: Type 316L stainless steel. Lower Housing: Type 316 stainless steel
5. Temperature Limit, High Side: -40 to 300 degrees F
6. Acceptable Manufacturer:
    a. Rosemount 1199.
    b. Accepted equal.

J. Capillary option:
1. Seal Location: High pressure side of transmitter, direct mounting.
2. Fill Fluid: DC 200 Silicone
3. Capillary Seal Connection Material: Type 316 stainless steel armored sleeving

4.07 INSTRUMENT IDENTIFICATION: PLG

A. Instrument Function: Pressure measurement

B. Instrument Description: Low range pressure gage

C. Power Supply: N/A

D. Signal Input: N/A

E. Signal Output: N/A

F. Process Connection: 1/2-inch male NPT

G. Product Requirements:
1. Pressure gages shall be 4-1/2-inch phenolic turret case construction with shatterproof glass window and 270-degree milled stainless steel movement.
2. Unless otherwise specified, element shall be ASTM A269, Type 316 stainless steel bellows. Gage shall be provided with a porous metal type snubber with ASTM A276, Type 303 stainless steel body and Type 316 stainless steel filter disc.
3. Pressure gage manufactures: Ashcroft Type 1188, or equal.

H. Execution:
1. Installation: Install in accordance with manufacturer's instructions and the recommendations of API RP551 to the specified requirements.
2. Root valves shall be provided at all process pressure taps except taps made for safety instruments. Gage valves shall be provided at the instrument where the instrument is not within sight of the root valve or where two or more instruments are connected to a single tap.
3. Safety instruments shall not be connected to the same process tap as instruments used for control, indication, or recording. Unless otherwise specified, pressure instruments shall be located as close as practical to the process tap but shall be positioned to permit observation and maintenance. Pressure gages may be supported from the process tap if this location permits observation from the floor or a permanent work platform.

4. Pressure instruments shall be installed in such a manner that blowout discs are not obstructed.

I. Application/Calibration: Application, calibration, and set points shall be as specified in Section 40 06 70-3.03.

4.08 INSTRUMENT IDENTIFICATION: PLS

A. Instrument Function: Pressure Measurement

B. Instrument Description: Pressure Switch, low range

C. Power Supply: N/A

D. Signal Input: Process

E. Signal Output: Contacts, in accordance with paragraph 2.02 of this section.

F. Process Connection: 1/4-inch female NPT

G. Product Data:
   1. Pressure switches shall consist of a pressure transducer and a precision switch. Pressure transducer shall be the diaphragm type with wetted materials as recommended by the switch manufacturer, or as specified in Section 40 06 70-3.03. The range spring isolated from process fluids by the diaphragm.
   2. The pressure connection shall be brass or aluminum unless otherwise specified. The pressure connection sufficiently sturdy to make the switch suitable for unsupported mounting. Switch housing shall be cast aluminum rated NEMA type 4 with 3/4-inch conduit connections unless otherwise specified.
   3. Approximate set point and, if applicable, reset point indicated on calibrated scales. Repeatability and sensitivity shall be 1.0 percent of operating range. Switches shall be non-adjustable dead-band, automatic reset type with of 0-2 inches water column.

H. Execution:
   1. Installation: Install in accordance with the manufacturer's instructions, Section 40 06 70-3.01, and the specified functional requirements.
   2. Test: In accordance with Section 40 06 70-3.02.

I. Application/Calibration: Application, calibration, and set points as specified in Section 40 06 70-3.03.

J. Approved Manufacturers: United Electric Series H400, or equal.

4.09 INSTRUMENT IDENTIFICATION: PS

A. Instrument Function: Pressure Measurement

B. Instrument Description: Pressure Switch

C. Signal Input: Process

D. Signal Output: As specified in paragraph 2.02

E. Process Connection: 1/2-inch female NPT

F. Product Requirements:

1. Pressure switch shall consist of a pressure transducer and a precision switch. Pressure transducer shall be the diaphragm piston type with wetted materials as recommended by the switch manufacturer. Piston backed by a cylinder disc to permit 10 times over-range pressure without affecting calibration.
2. Range spring and piston shall be isolated from process fluids by the diaphragm. Switch provided with two 3/4-inch conduit connections. Switch assembly housing shall be cast aluminum rated types 3, 4, and 7D per NEMA ICS6. Contractor shall select pressure transducer so that set point falls between 30 and 70 percent of maximum range.
3. Approximate set point and, if applicable, reset point indicated on calibrated scales. Repeatability and sensitivity shall be 1.0 percent of operating range. Unless otherwise specified, switches nonadjustable deadband type.

G. Approved Manufacturers: SOR Inc. Static-O-Ring, Mercoid Series 1000, or equal.

H. Execution:

1. Installation: Install in accordance with manufacturer's instructions and to the specified requirements.
2. Application/Calibration: Application, calibration, and set points as specified in Section 40 06 70-3.03.

END OF SECTION

SECTION 40 74 00

TEMPERATURE MEASUREMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies requirements for process temperature transmitters, associated indication devices, and accessories.

B. This section specifies requirements for process temperature indicators, and accessories.

1.02 QUALITY ASSURANCE

A. Manufacturer:
   1. Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of five years.

B. Installer:
   1. Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled, Certified Technicians specified in Section 40 61 13, who are regularly engaged in such activities involving systems of similar complexity.

C. References:
   1. Refer to Section 40 61 13. They are a part of this section as specified and modified.

1.03 SUBMITTALS

A. Submittals shall be provided as specified in Sections 01 33 00 and 40 61 13.

B. Provide separate submittals for each of the Intake PS and LeChee WTP for the following:

C. Action Submittals - Shop Drawings:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Referenced and applicable sections to be marked up and submitted include:
      a. Section 40 61 13 – Process Control System General Provisions
      b. Section 40 06 70 – Instrument Index

      A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.

The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications.

Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. A copy of the following contract document Control Diagrams and Process and Instrumentation Diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
    a. Intake PS: E-100, E-101, E-102, E-103, and E-106.
    b. LeChee WTP: E-00-131, E-00-511 through E-00-516, I-00-101, and all P&IDs with temperature instruments.
3. Marked Contract Document Mechanical and/or Electrical Plan drawings, sections, and details showing sensor installation locations and details. Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
4. Marked product literature of all equipment and features to be provided.
    a. Installation drawings for only the transmitters, sensors, and mounting accessories to be provided.
    b. Electrical and signal connection drawings for only the transmitters and sensors to be provided.
5. List of miscellaneous items, cables, spare parts, that will be provided in accordance with INSTRUSPEC sheet requirements.

D. Informational Submittals.
1. Test results as specified in Section 40 61 21-2.02.

E. Closeout Submittals - Operating and Maintenance (O&M):
1. Include the following in each O&M Manual:
    a. Final reviewed submittals.
    b. Manufacturer’s O&M instructions, edited for this project.
    c. Written record of menu configuration, jumpers, switch settings, and other configurable parameters for each instrument.
    d. Include list of spare parts and tools provided.

1.04 ENVIRONMENTAL CONDITIONS

A. Equipment provided under this section shall be suitable for operation under ambient conditions described in Section 40 61 13-1.03.

PART 2 PRODUCTS

2.01 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

A. General requirements for instruments specified in this section are specified on the INSTRUSPEC sheets in the Appendix at the end of this section.

B. Application requirements are specified in Section 40 06 70-3.03, and/or on the drawings.

2.02 EQUIPMENT

A. General:

1. In accordance with Section 01 33 00 the General Conditions of the Contract Documents, drawings, information, and technical data for all equipment as, required in Section 40 61 13 and this section shall be provided. All required product data for this section shall be included in one complete package.
2. The Owner and Construction Manager require the specified Manufacturer to provide the equipment and/or products to be furnished under this Section. The Owner and Construction Manager believe the Manufacturer is capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed to mean that the named Manufacturer's standard product will comply with the requirements of this Section.
3. Where only one Manufacturer and model is specified, they shall be as specified for the purpose of compatible and efficient utilization of existing equipment, supplies, and personnel training and experience, no substitutions are permitted.

B. Process switches and devices shall comply with the following requirements:

1. Contact outputs used for alarm actuation shall be normally-closed or normally-opened as required by the process condition to open to initiate the alarm.
2. Contact outputs used to control equipment shall be normally-opened and shall close to start the equipment.
3. Contacts monitored by solid state equipment such as programmable controllers or annunciators shall be hermetically sealed and rated for switching currents from 20 to 100 mA at 24 volts DC.
4. Contacts, monitored by electromagnetic devices such as mechanical relays, shall be rated as NEMA ICS 2, designation B300.
5. Double barriers provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.
6. Switch electrical enclosures rated as NEMA 250, Type 4 minimum.
7. Not used.
8. Switch range shall be selected so that the specified set point is at least 30 percent but not more than 70 percent of the span, between the upper range limit and the lower range limit.

C. Measuring elements and transmitters shall comply with the following requirements:
   1. Measured parameter output indicators complying with paragraph 2.02 shall be provided with any transmitter that does not include an integral indicator. Indicators, whether integral or separate, shall be calibrated in process units, and engraved on the indicator scale plate.
   2. The two-wire type transmitters shall have operating power derived from the signal transmission circuit.
   3. Transmitters shall meet specified performance requirements with load variations within the range of 0 to 600 ohms with the power supply at a nominal 24 volts DC with the default range of 0 to 100% linearly corresponding to 4 to 20 mAdc.
   4. Transmitter output shall increase with increasing measurement.
   5. Time constant shall be adjustable from 0.5 to 5.0 seconds for transmitters used for flow, level transmitters used for flow measurement, or pressure measurement.
   6. Transmitter output shall be galvanically isolated via electro-mechanical or optical technology.
   7. Transmitter enclosures shall be rated NEMA 250, Type 4, unless otherwise specified.
   8. Not used.

2.03 NOT USED

2.04 NOT USED

2.05 NOT USED

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. General requirements for the installation of primary elements specified in this section are listed on INSTRUSPEC sheets.
   2. Installation requirements are specified in Section 40 61 13-3.01.

B. Electrical Connections:
   1. Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of 2 feet.

3.02 TESTING

A. Applicable testing requirements are specified in Section 40 06 70-3.02.

B. Testing requirements are specified in Section 40 61 21.

3.03 NOT USED

3.04 TRAINING

A. Training requirements are specified in Sections 01 79 00. Provide two training sessions, each with one-half hour for each type of level transmitter.

PART 4 APPENDIX - INSTRUSPECS

4.01 INSTRUSPECS

A. General requirements for instruments specified in this section are listed on INSTRUSPEC sheets herein. Application requirements are specified in the Instrument Index, and/or on the drawings.

INSTRUSPEC Symbol	Instrument description	Instrument function
TMI	Bi-metal temperature indicator	Temperature measurement
TMP	Temperature Transmitter	Temperature measurement
TRE	Resistance temperature insertion type RTD	Temperature measurement
TS	Temperature Switch	Temperature measurement

4.02 INSTRUMENT IDENTIFICATION: TMI

A. Instrument Function: Temperature measurement

B. Instrument Description: Bi-metal temperature indicator

C. Power Supply: N/A

D. Signal Input: Process

E. Signal Output: N/A

F. Process Connection: 1/2 -inch male NPT

G. Product Data:
   1. Temperature indicators shall be operated by the expansion or contraction of a bimetallic element. Temperature indicators shall be hermetically sealed with an external zero adjuster. Case, ring, and stem material shall be Type 316 stainless steel.
   2. Dial shall be 5 inch, 270-degree movement, with an acrylic window. Scale shall be marked at least every 2 degrees F. Major scale divisions shall be at 10-degree F. intervals and scale shall be numerically noted at 20-degree F. intervals.
   3. Dial angle shall be adjustable over a 90-degree arch with respect to the stem. Stem length shall not exceed 4 inches and diameter shall not exceed 1/4 inch unless otherwise specified. Accuracy shall be plus or minus 1 percent of span, or better.

H. Execution:
   1. Installation: Install in thermowells specified in paragraph 2.05 of this section in accordance with the manufacturer's instructions, Section 40 06 70-3.01, and the specified functional requirements.
   2. For pipelines less than 4-inch diameter, thermowell shall be installed in a pipeline elbow if possible. Where elbow is not available, a wye fitting shall be installed in the pipeline for installation of the thermowell at a 45-degree angle with the flow.
   3. Test: In accordance with Section 40 06 70-3.02.

I. Application/Calibration: Application, calibration, and set points shall be as specified in Section 40 06 70-3.03. Bi-metallic temperature device manufacturers:
   1. Ashcroft model 50EI42E
   2. or equal.

4.03 INSTRUMENT IDENTIFICATION: TMP

A. Instrument Function: Temperature Measurement

B. Instrument Description: Temperature Transmitter

C. Power Supply: As specified in paragraph 2.02

D. Signal Input: Process temperature monitored by RTD

E. Signal Output: Analog transmission signal as specified in paragraph 2.02

F. Process Connection: Integral or remote mounting to sensor and thermowell, as specified in Section 40 71 00.

G. Product Requirements:
   1. Temperature Transmitter: 2-wire device, powered from the PLC analog input power supply.
   2. Temperature Limits: 0-160°F.
   3. Humidity Limits: 0-100% RH.
   4. Accuracy: 0.25°F + 0.02% span, using 100 Ohm Platinum RTD.
   5. Output: One isolated 4-20 mA into a maximum of 600 ohms.
   6. Sensor update time: 0.5 seconds.
   7. Failure mode: transmitter shall have a configurable failure mode to drive the analog signal either high (>21 mA) in the event of microprocessor failure.
   8. Rating: NEMA 4X or as specified in 40 06 70 Instrument Index.
   9. Indicator: LCD display.
   10. Acceptable Manufacturer:
      a. Endress+Hauser TMT-142.
      b. Accepted equal.

H. Calibration:
   1. Factory-certified calibration report for the range specified in Section 40 06 70, not for manufacturer's standard range.

I. Execution:
   1. Installation: Install in accordance with manufacturer's instructions and the Engineer's installation detail.

4.04 INSTRUMENT IDENTIFICATION: TRE

A. Instrument Function: Temperature measurement

B. Instrument Description: Resistance temperature detector element, inserting type

C. Power Supply: N/A

D. Signal Input: Process

E. Signal Output: 100 ohms nominal at 0 degrees C, resistance temperature coefficient of 0.385%/degree C

F. Process Connection: 1/2-inch male NPT

G. Product Requirements:
   1. Temperature element shall be tip sensitive, three-wire platinum resistance temperature detector (RTD) in 1/4-inch ASTM A269, Type 316 stainless steel sheath with watertight connection head.
   2. Time constant in agitated water shall not exceed 8 seconds. RTD shall comply with ASTM E1137, tolerance Grade A
   3. RTDs for installation in wells shall be provided with spring loading device and union coupler. Union shall extend out beyond pipe lagging.
   4. Three-wire lead configuration for ambient temperature compensation shall be provided. RTD extension cable conductors shall be shielded triads as specified in Division 26.
   5. Bushings and wells for temperature elements shall comply with ASME B40.200 and unless otherwise specified shall be machined from ASTM A276, Type 316 stainless steel bar stock. Union couplers shall be provided for all temperature elements.

H. Execution:
   1. Installation: Temperature elements shall be installed in accordance with the manufacturer's instructions.

4.05 INSTRUMENT IDENTIFICATION: TS

A. Instrument Function: Temperature Measurement

B. Instrument Description: Temperature Switch

C. Power Supply: N/A

D. Signal Input: Process

E. Signal Output: Contact as specified in paragraph 2.02

F. Process Connection: 1/2-inch male NPT

G. Product Requirements:
   1. Temperature switch assembly shall consist of a SAMA PMC6-10, Class 2 filled thermal element and pressure switch connected by a capillary tube or close coupled as specified.
   2. Temperature element shall be ASTM A269, type 316 stainless steel with SAMA PMC6-10 dimensions of X equal to or less than 5 inches, Y equal to 3/8-inch nominal, and U as specified.
   3. Temperature switch assembly provided in three ranges with the following characteristics:

Adjustable range, degrees F	Maximum deadband, degrees F	Permissible overrange, degrees F
-50 to 70	15	180
40 to 225	12	360
150 to 375	15	520

H. Switch performance shall not be altered by bulb exposure to the specified over-range temperature.

I. Execution:
   1. Installation: Temperature switch installed in accordance with the manufacturer's instructions and to the specified requirements with Union couplers provided.

END OF SECTION

SECTION 40 75 00

PROCESS LIQUID ANALYTICAL MEASUREMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies requirements for process fluid analyzer indicating transmitters.

1.02 QUALITY ASSURANCE

A. Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of five years.

B. Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled, Certified Technicians specified in Section 40 61 13, who are regularly engaged in such activities involving systems of similar complexity.

C. References are listed in Section 40 61 13 and are a part of this section as specified and modified.

1.03 SUBMITTALS

A. Submittals shall be provided as specified in Sections 01 33 00 and 40 61 13.

B. Provide separate submittals for LeChee WTP for the following:

C. Action Submittals – Shop Drawings:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Referenced and applicable sections to be marked up and submitted include:
   a. Section 01 79 00 – Demonstration and Training
   b. Section 40 61 13 – Process Control System General Provisions
   c. Section 40 06 70 – Instrument Index
      1) Lechee WTP.

   A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.

   The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. A copy of the following contract document Control Diagrams and Process and Instrumentation Diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal.

   If no changes are required, the drawing or drawings shall be *marked* "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

   a. LeChee WTP: E-00-131, E-00-511 through E-00-516, and all P&IDs with analyzers.

3. A copy of the following contract document Mechanical Drawings relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal.

   If no changes are required, the drawing or drawings shall be *marked* "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

   a. LeChee WTP: All Mechanical plans and/or sections showing analyzer element piping installation.

4. Marked Contract Document Mechanical and/or Electrical Plan drawings, sections, and details showing sensor installation locations and details. Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
5. Marked product literature of all equipment and features to be provided.
   a. Installation drawings for only the analyzers, sensors, and mounting accessories to be provided.
   b. Electrical and signal connection drawings for only the analyzers and sensors to be provided.
6. List of miscellaneous items, cables, spare parts, replenishment parts, and chemicals that will be provided in accordance with INSTRUSPEC sheet requirements.

D. Informational Submittals.
   1. Test results as specified in Section 40 61 21-2.02.

E. Closeout Submittals - Operating and Maintenance (O&M):
   1. Include the following in each O&M Manual:
      a. Final reviewed submittals.
      b. Manufacturer's O&M instructions, edited for this project.
      c. Written record of menu configuration, jumpers, switch settings, and other configurable parameters for each instrument.
      d. Include list of spare parts, replenishment parts, chemicals, and tools provided.

1.04 ENVIRONMENTAL CONDITIONS

A. Refer to Section 40 61 13.

PART 2 PRODUCTS

2.01 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

A. General requirements for instruments specified in this section are specified on the INSTRUSPEC sheets in the Appendix at the end of this section.

B. Application requirements are specified in Section 40 06 70-3.03 – the Instrument Index, and/or on the drawings.

2.02 EQUIPMENT

A. General:
   1. In accordance with Section 01 33 00 the General Conditions of the Contract Documents, drawings, information, and technical data for all equipment as required in Section 40 61 13 and this section shall be provided. All required product data for this section shall be included in one complete package.
   2. The Owner and Construction Manager require the specified Manufacturer to provide the equipment and/or products to be furnished under this Section. The Owner and Construction Manager believe the Manufacturer is capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed to mean that the named Manufacturer's standard product will comply with the requirements of this Section.
   3. Where only one Manufacturer and model is specified, they shall be as specified for the purpose of compatible and efficient utilization of existing equipment, supplies, and personnel training and experience, no substitutions are permitted.

B. Process fluid analyzers shall comply with the following requirements:
   1. Measured parameter output indicators shall be calibrated in process engineering units.
   2. Transmitter output shall increase with increasing process measurement, except where specified as "reverse action" in the Instrument Index.
   3. Four-wire transmitters shall be isolated from the process and power.
   4. One analyzer transmitter shall be provided for each sensor. Dual sensor analyzer capability shall not be utilized.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation requirements are specified in Section 40 61 13-3.01.

3.02 TESTING

A. Testing requirements are specified in Section 40 61 21.

3.03 TRAINING

A. Training requirements are specified in Sections 01 79 00. Provide two training sessions, each with one hour per type of Analyzer .

3.04 INSTRUMENTATION SPECIFICATION (INSTRUSPEC) SHEETS

A. General requirements for instruments specified in this section are listed on INSTRUSPEC sheets herein. Application requirements are specified in the Instrument Index, Section 40 70 00, and/or on the drawings.

B. INSTRUSPEC sheets for the analyzers listed in the following Table A are included in this paragraph:

Table A: List of Process Fluid Analyzer Indicating Transmitters

INSTRUSPEC Symbol	Analyzer Description	Instrument Function
AH	Hydrogen-ion Analyzer (pH)	Analyzer Indicating Transmitter
CLR	Chlorine Residual Analyzer	Analyzer Indicating Transmitter

3.05 AH INSTRUMENT SPECIFICATION SHEET–INSTRUSPEC

A. Instrument Identification: AH

B. Instrument Description: Hydrogen-ion Activity (pH) Analyzer

C. Power Supply: 120 volts AC

D. Signal Output:
   1. 4 to 20 mA into 0 to 500 ohms, isolated, HART Communications protocol
   2. Three Form-C relay outputs

E. Process Connection: Submersion

F. Product Requirements:
   1. Analyzer: Analyzer transmitter shall be pipe/surface mount, NEMA 4X with integral keypad/display and self-diagnostics, and shall be Hach SC200, or equal.
   2. Sensor: pH measurement shall be made with a differential glass electrode, titanium ground electrode, integral preamplifier, 15 foot cable, and glass-filled polyetheretherketone (PEEK) body with 1" NPT threading on both ends. Non-differential sensors are not acceptable. Sensor rated 100 psig, 10 fps flow. Sensor shall be Hach / GLI DPD1P1, or equal.
   3. Replenishment Parts: One salt bridge and one bottle of standard cell solution for each sensor/analyzer.
   4. Junction Box: Hach / GLI 60A2053, or equal.
   5. Extension Cable: Hach / GLI 1W1100, or equal.
   6. Calibration Buffers: Two sets of each of pH 7 and 10 buffers. Use one set for testing/calibration and training, second set for Owner.
   7. Mounting Accessories: As required for the installation specified on the drawings, provided by sensor Manufacturer. Insertion mount unit, CPVC, 1-1/2" NPT, Hach / GLI MH736M4MZ.

G. Execution:
   1. Installation: Insertion assemblies shall be installed per Manufacturer instructions.
   2. Application/Calibration: In accordance with Section 40 70 00-3.03.

3. Manufacturer Services: Two hours per analyzer on-site, minimum one day.

3.06 CLR INSTRUMENT SPECIFICATION SHEET–INSTRUSPEC

A. Instrument Identification: CLR

B. Instrument Description: Chlorine (Free) Residual Analyzer

C. Power Supply: 120 volts AC

D. Signal Output:
   1. 4 to 20 mA into 0 to 500 ohms, isolated, HART Communications protocol.
   2. Two Form-C relay outputs.

E. Process Connection: Sample 1/4" NPT

F. Product Requirements:
   1. Analyzer: Analyzer shall consist of an amperometric sensor, measuring cell and electronic operator controls. Analyzer shall be specific to free chlorine and shall be provided in a surface mountable enclosure.
   2. The analyzer's electronics shall be microprocessor-based with a wall mount touch key pad and alphanumeric display. Electronic components shall be housed in NEMA 4X enclosures. Unit shall have Automatic pH compensation. Unit shall be Endress & Hauser CCM253.
   3. Sensor: The measuring cell shall be of the flow-through type with a sensor which shall produce a signal proportional to chlorine residual. Unit shall be Endress & Hauser CCS141 sensor ,one CPS11 pH sensor and CPK cable, and CCA250 flow cell.
   4. Replacement Parts: One sensor of each type.
   5. Junction Box: Endress & Hauser VBC, one for chlorine and one for pH.
   6. Extension Cable: Endress & Hauser CMK for chlorine and CYK for pH.
   7. Calibration Tool: Photometer, Endress & Hauser CCM182.

G. Execution: Install and calibrate instrument in accordance with manufacturer's recommendations. Provide additional components as shown and required by the manufacturer: PRV, needle valves, rotameter, strainer, etc.
   1. Application/Calibration: In accordance with Section 40 70 00-3.03. Owner will assist with calibration and provide hand-held test kit. Owner will witness calibration.
   2. Manufacturer Services:Two hours per analyzer on-site, minimum one day.

END OF SECTION

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SECTION 42 23 71

MULTI-STAGED SUBMERSIBLE PUMPS INTAKE BUILDING

PART 1 GENERAL

1.01 DESCRIPTION

A. SCOPE:

1. This section specifies multi-staged Grundfos submersible Stage-1 pumps to be installed in existing well shafts D and E of the Intake PS; see plan set Volume 1 LeChee Intake Structure and Control Building sheets C-004 and C-007. The pumping arrangement shall be complete with a new connection reducer 300 lb. ANSI FL 16"x 6"NPT, control cable, power cable, level transmitter, and the Grundfos multi-staged submersible motor incorporated into the existing 36" well shaft using the existing 16" flanged piping, roller system and cable clamps; see sheet C-007.
2. Stage 2 pumps, refer to Section 43 23 92.01 – Volume 1 Intake Facility.

B. TYPE:

1. Equipment furnished under this section shall be a multi-stage submersible pump and controller by "Grundfos Pumps' designed specifically for pumping water from an existing well shaft using a variable speed control system to maintain Net Positive Suction Head (NPSH) at the Stage-2 intake Booster Pump inlet. The pump shall be complete with a submersible motor, inlet strainer, suction screen casing, chambers/impellers, discharge column, and check valve.

C. PUMPED FLUID AND OPERATING CONDITIONS:

1. The fluid to be pumped by the equipment furnished under this section will be from Lake Powell.

D. GRUNDFOS MULTI-STAGED PUMP AND CONTROLLER PRODUCT INFORMATION:

1. Multi-Staged Submersible Pump Model: 800S750-3, 75 hp, Flow 710 gpm, TDH 309 feet @ 3450rpm.Pump Material Stainless Steel. Impeller Stainless Steel AISI 304.
2. VFD: Provide per Section 26 29 23.

1.02 QUALITY ASSURANCE:

A. REFERENCES:

1. This section contains references to the document(s) listed below. These documents are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section or any referencing section and those of the listed documents, the following order of precedence shall prevail (in the order of primacy):
   a. This section
   b. The referenced section
   c. The referenced document

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement For Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AISC	American Institute of Steel Construction Manual of Practice
ANSI/HI 9.1 – 9.5	Pumps – General Guidelines
ASTM A48	Standard Specification for Gray Iron Castings
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
AWWA E102	Submersible Vertical Turbine Pumps
NSF/ANSI 61	Drinking Water System Components – Health Effects

B. QUALITY CERTIFICATION:
   1. All manufacturers for supply of equipment furnished under this section and sections referencing this section shall be prepared to document quality assurance procedures conforming to ISO 9001. The documentation shall include the manufacturer's written Quality Assurance/Quality Confirmation (QA/QC) program and the documentation plan conforming to ISO 9001.

C. PERFORMANCE CONFIRMATION:
   1. HYDROSTATIC TESTS: All pressure sustaining parts shall be subjected to factory hydrostatic tests. Hydrostatic tests shall conform to the requirements of ANSI/HI 14.6, revised to be tested for a minimum of thirty (30) minutes.
   2. PERFORMANCE GUARANTEE: Pump performance, including efficiency and NPSH, shall be guaranteed by the pump manufacturer to the criteria specified under this paragraph.
      a. Equipment performance documentation, including test data, shall include sufficient test points to document hydraulic performance along the complete head/capacity curve from shutoff to maximum capacity and shall cover all full speed operating point specified in the detailed specification section referencing this Section. Tests conducted at specified operating conditions shall be the inlet throttled to product the NPSHA indicated for that specific condition in the detailed specification.

1.03 DESIGN REQUIREMENTS

A. GENERAL:

1. Equipment furnished in this section shall be designed for a minimum service life of 20-years. All components associated with the rotating elements in the drive train, including equipment supports and supports for rotating elements, shall be selected and designed to function without damage or disassembly at reverse rotational speeds up to 150 percent of maximum operational speed during flow reversals through the pump. The complete pumping unit shall operate without overload on any component at any point along the pump's entire full-speed operating curve. Pumps required by virtue of the specified operating conditions to operate against a closed valve or throttled for any period of time exceeding five seconds shall be furnished with drivers sized to operate continuously at the power requirement for that condition even though the power requirements at the rated condition may be less.

B. PUMP SELECTION:

1. The pump shall operate without cavitation or damaging vibration for the specified range of flow and head conditions.
2. Unless otherwise noted or specified, pump head capacity curve shall slope in one continuous curve within the specified operating conditions. No points of reverse slope inflection capable of causing unstable operation will be permitted within the specified zone of continuous duty operation.

C. CRITICAL SPEEDS AND NATURAL FREQUENCIES:

1. LATERAL ROTOR DYNAMICS: The complete pumping unit, including all related frames, supports, enclosures, and casings, shall be free from dangerous critical speeds from 20 percent below to 30 percent above the operating speeds required to achieve the specified performance characteristics. The logarithmic decrement for each damped natural frequency (forward or backward) shall be greater than +0.3, and the amplitude magnification factor shall not exceed 3, for any natural frequency within this range.
    a. Process sensitivities are such that operation at infinitely variable speed within the specified operational conditions is an absolute requirement. Any remedy imposing a locked-out speed interval or intervals will not be considered an acceptable remedy for identified critical speeds. Acceptable remedies include combinations of adjustments in rotor geometry or materials, and the substitution of energy absorbing couplings. Other remedies may be considered so long as they are justified in writing and the proposal sealed and signed by the design professional retained by the manufacturer to perform the system mass elastic system analyses.

2. TORSIONAL AND COMBINED SHAFT STRESS: The pump rotor shall be free from torsional response which produces combined (steady plus alternating torque induced) stresses exceeding 30 percent of the material's elastic limit (but no more than 18 percent of the material's ultimate tensile strength) at any speed from 10 percent below to 20 percent above that required by the specified operating conditions, or during startup, shutdown or motor control transients. In accordance with MIL STD 167-2, under no circumstances shall combined (torsional steady and alternating) peak shear stresses, at points of stress concentration calculated in accordance with the requirements of this section, exceed 4 percent of the material's ultimate tensile strength, nor more than 50 percent of the material's fatigue limit, whichever is less.

D. COMPONENT DESIGN CRITERIA:
   1. Unless otherwise specified, combined stresses in steel frames and supports shall not exceed those permitted by the AISC Manual of Practice. Combined stresses in cast, forged, rolled, or fabricated pressure retaining components, frames and supports shall not exceed that allowed for the given material in Section VIII, Division 1 of the ASME Code. Design pressures for pressure-retaining parts shall be not less than twice the pump's shutoff head at the manufacturer's listed maximum operating speed. Pump casing strain at any head on the full speed operating curve (including allowances for increases caused by specified multi-stage applications) shall not result in distortions at the bearing housings greater than the maximum allowable by the bearing manufacturer to provide the specified bearing life.
   2. The term "combined stresses" in this section shall mean the sum of all operating stresses, including stresses induced by dynamic and static forces as developed via the analysis procedures stipulated in this section. Static forces (x, y, z, and moments in all planes) shall include the relevant maximum nozzle loads specified in ANSI/HI 9.6.2 or as stipulated by the pump manufacturer. Dynamic forces shall include both steady state and transient stresses induced by operating conditions within the zone of operation established by the specified operating conditions.

E. ELECTRIC MOTORS:
   1. Unless otherwise specified, pumps shall be electric motor driven. All motors shall be selected to be non-overloading at any operating point along the pump's full speed operating curve, including all points located beyond specified operating conditions.
   2. Motor shall be inverter duty.

1.04 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 00.

B. Action Submittals - Shop Drawings:

1. A copy of this specification section and the referencing section and all other applicable specification sections governing the pump, drive and driver, supports and specified appurtenances. The specification copies shall be complete with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. A copy of the contract document Electrical Drawings E-102, E-103, E-104, and E-108, and Mechanical Drawings relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
3. Documentation of certification of quality as specified under paragraph 1.02 B.
4. Predicted pump performance curve for the condition point specified showing head, power, efficiency, and NPSH required on the ordinate plotted against capacity (in gpm) on the abscissa. All curves shall clearly display the specified operating conditions
5. Submersible motor information, including motor cable specifications and size.
6. Drawings showing general dimensions and confirming the size of pumps, motors, drives and specified appurtenances; piping connections; construction details of equipment; wiring diagrams; and weight of equipment.
7. Drawings for the Pump Controller, including internal and external dimensioned layout and nameplates, and showing connections to the VFDs, provided instruments and controls, and to the Telemetry PLC provided by Others.
    a. Include a copy of Spec. 40 61 96-3.10, check-marked to show compliance or marked to show deviations.
8. Any temperature or moisture protection sensor and associated control relay product literature and connection diagrams.
9. Spare parts to be provided.

C. Action Submittals – Variable Frequency Drives:

1. Refer to Section 26 29 23.
2. Submit with pump shop drawings, or submit separately.

D. Informational Submittals:

1. Installation Certification Section 43 05 11-Form A as specified in paragraph 3.01.
2. Training Certification Section 43 05 11-Form B as specified in paragraph 3.02.

3. Certification of satisfactory factory testing for GRUNDFOS MULTI-STAGED PUMP, VFD, AND CONTROLLER . The certified factory testing shall include copies of test logs and resulting performance curves.

E. Closeout Submittals – Operations and Maintenance:
   1. Per Section 01 78 23.
   2. Include copy of final reviewed submittal.

F. Closeout Submittals – Spare Parts.
   1. Per Section 01 78 23

1.05 UNIT RESPONSIBILITY

A. All mechanical equipment components, at least, of this entire equipment assembly shall be furnished by the pump manufacturer. This manufacturer is the unit responsibility manufacturer as specified in Section 43 05 11, and has unit responsibility for the equipment assembly specified in this section, pump controller, and for the Variable Frequency Drives specified in Section 26 29 23. A completed, signed, and notarized Certificate of Unit Responsibility (Form 43 05 11-C, Section 01 99 90) shall be provided.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. The following manufacturer is capable of producing equipment and/or products satisfying the requirements of this section. Manufacturers and models shall be as specified for the purpose of compatible and efficient utilization of existing equipment, supplies, and personnel training and experience, no substitutions are permitted.

B. The pump manufacturer shall be Grundfos or approved equal. Motor manufacturers shall be Grundfos or approved equal. Units shall meet requirements of AWWA E102 unless modified by these specifications.

2.02 MATERIALS

A. Materials shall conform to the following:

Component	Material
Pump	Stainless Steel, EN 1.4301, AISI 304
Impeller	Stainless Steel, EN 1.4301, AISI 304
Chamber	Stainless Steel, EN 1.4301, AISI 304
Motor	Stainless Steel, EN 1.4301, AISI 304
Discharge column pipe	Steel, ASTM A53, Class B, Standard Weight
Strainer	Stainless steel, ASTM A240, Type 304
Bolts, studs, and nuts	Stainless steel, ASTM A276, Type 304
Pitless Unit	Baker Manufacturing Company, Monitor Division

2.03 EQUIPMENT FEATURES

A. MOTOR ADAPTER:

1. The bottom of the pump shall be fitted with a one piece casting motor adapter designed to serve as the suction inlet, lower bearing housing and motor adapter piece. The coupling housing portion shall be designed to prevent the entrance of abrasive material into the top end of the motor. The coupling connecting the motor to the pump bowl assembly shall be of sufficient size and strength to withstand maximum torque generated by the motor.

B. STRAINER:

1. The suction inlet shall be provided with a strainer having a net inlet opening area of not less than four times the impeller inlet area. The strainer or mesh openings shall be sized to prevent passage of particles larger than the solids handling capability of the impeller.

C. SUCTION INLET:

1. The suction case shall be designed to provide conservative entrance velocities and evenly distribute the flow to the impeller. The inner surface of the case shall be smooth and free from projections or cavities. The pump shaft lower bearing shall be housed in a streamlined casing, centered and held in place by means of rigid cast vanes.

D. CHAMBERs

1. The impeller chamber shall be stainless steel.

E. IMPELLERs:

1. The impeller shall be constructed free from projections, cavities, or abrupt transitions. The impeller surfaces shall be stainless steel. Impellers shall be of the enclosed type, with the shroud designed to rotate against wearing rings installed in the bowl (chamber) assembly. Impellers shall be secured to the pump shaft using tapered collets or keyways.

F. SHAFTS:

1. Shafts shall be sized to prevent excessive elongation and transmit the required torque without distortion in both the forward and reverse direction. Shafts shall have a first critical speed not less than 20 percent above maximum operating speed. The pumping units shall utilize a single pump shaft extending from the suction case through a discharge case or upper bowl case containing an upper pump shaft bearing.

G. DISCHARGE COLUMN PIPE:

1. Column pipe shall use the existing 16-inch piping designed to support the weight of all equipment full of water. The pipe will be secured so that it will not unscrew. Column interior shall be free of offsets, burrs, discontinuities, or irregularities. The column shall be supplied in sections not exceeding 20 feet in length. Lubrication for threads shall be Food Grade oil approved by the Food and Drug Administration (FDA). API couplings shall be equal to Capital Manufacturing, conforming to the requirements of API 5L.

H. Submerisble pump cable:

1. The submersible multiconductor cable shall be stranded and sized per the manufacturer's recommendation and the contract drawings for the motor size specified, meeting ASTM class B. Cable assembly and wire insulation shall be heat and moisture resistant suitable for continuous immersion in water. The cable shall have sufficient area to meet ICEA requirements for operation in air. Cable shall be mechanically shielded where it passes the pump bowls. Sufficient cable shall be provided to reach from the motor to the surface splice box without splices. The length of cable shall include adequate length to account for sagging of the cable, or wrapping around the column pipe. The cable shall be supported on the column pipe with stainless steel straps every 20 feet.
2. The submersible pump cable shall be Service Wire with three stranded copper wire conductors insulated with color coded PVC of THW type paralleled with green insulated ground. The cable has dimensions of 0.7 in. by 2.12 in.

I. Pump/motor moisture temperature protection:

1. If required, provide motor and or temperature sensors. Provide any separate motor and/or temperature protection relay. Coordinate addition of the relay into the VFD.

2.04 COLUMN CHECK VALVES

A. The pump shall be equipped with a column check valve. The check Valve shall meet all strength requirements for the column pipe.

2.05 TRANSDUCER

A. The submersible level transmitter (transducer) shall be equal to Dwyer. The level transmitter shall have an accuracy of +0.25% FS and a range of 400 psi. Cable shall be polyether polyurethane and have length of 950 linear feet to extend from the level transmitter setting to the Well House telemetry PLC Cabinet. Output signal shall be 4-20 mA DC, 2-wire. The transducer will be placed in a 1" schedule 80 PVC pipe, meeting ASTM D1785.

2.06 SPARE PARTS

A. Spare parts shall include all special tools and test equipment required for the proper servicing of all equipment, as well as one set of spare parts as recommended by the pump manufacturer.

2.07 PUMP CONTROLLER

A. The controller shall be provided in a NEMA 12 enclosure. Power shall be 120Vac.

B. Refer also to Section 43 23 92.01 – Volume 1 Intake Facility.

C. Provide one controller for the entire system of two Stage 1 and two Stage 2 pumps.

D. Pump system programming parameters shall be available and/or field adjustable.

E. Pump curve data shall be loaded into the pump system controller.

F. Warnings and alarms shall be displayed.

G. Selector switches, pilots, and other controls for each VFD shall be on the VFD, not on the pump controller.

H. The controller shall interface with the Telemetry PLC, which communicates with the Raw Water Tank at the LeChee WTP. Hardwired input/output interconnections shall include the following signals:
   1. Discrete inputs:
      a. System auto start/stop (dry contact from Telemetry).
   2. Discrete dry contact outputs:
      a. System run.
      b. System fault alarm.
      c. Phase loss alarm.
      d. Control panel intrusion alarm.
      e. For each pump:
         1) Hand-Off-Auto selector switch in Hand.
         2) Hand-Off-Auto selector switch in Auto.
         3) Run status.
         4) Alarm.
   3. Analog inputs:
      a. Stage 1 Discharge/Stage 2 Suction Pressure.
      b. Stage 2 Discharge Pressure
   4. Analog outputs:
      a. Stage 1 Discharge pressure.
      b. For each pump:
         1) Motor current.

I. Communications from the Controller to the four VFDs shall be via Ethernet Cable, with protocol per the Manufacturer.

J. The controller shall start and stop pumps based on command from the Telemetry PLC as specified in Section 40 61 96-3.10.

PART 3 EXECUTION

3.01 INSTALLATION

A. Each pumping unit shall be aligned, connected, and installed in accordance with the manufacturer's recommendations.

B. The installation shall be certified on Form 43 05 11-A as specified in Section 01 99 90.

3.02 FIELD QUALITY CONTROL

A. After completion of installation, each pumping unit shall be field tested to demonstrate compliance with the performance requirements as specified.

B. Training:
   1. A minimum of 2 hours of onsite training shall be provided by the pump manufacturer's service representative.
   2. Training shall conform to Section 01 79 00.
   3. Certify completion of training on Form 43 05 11-B as specified in Section 01 99 90.

C. Manufacturer Services, coordinate with Section 43 23 92.01 - Volume 1 Intake Facility:
   1. Installation Inspection, Assist, supervise, and inspect the Contractor's activities during installation. Provide 6 hours onsite for each pump.
   2. Assist the Contractor in preparing test procedures as specified in Section 01 45 20.
   3. Component Test Phase Inspections: Assist, supervise, and inspect the Contractor's activities during the system test phase specified in Section 01 45 20 and this Section. Provide 6 hours onsite for each component.
   4. System Test Phase Inspections: Assist, supervise, and inspect the Contractor's activities during the system test phase specified in Section 01 45 20. Provide 24 hours onsite.
   5. Operational Test Phase Inspections: Assist, supervise, and inspect the Contractor's activities during the operational test phase specified in Section 01 45 20. Provide 16 hours onsite.

END OF SECTION

SECTION 43 05 11

GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies general requirements which are applicable to all mechanical equipment. The Contractor is responsible for ensuring that all mechanical equipment meets the requirements of this section in addition to the specific requirements of each individual equipment specification section.
      a. Requirements in individual equipment specification sections shall supersede conflicting requirements in this section

B. Equipment Lists:
   1. Equipment lists, presented in these specifications and as specified on the drawings, are included for the convenience of the Construction Manager and Contractor and are not complete listings of all equipment, devices and material required to be provided under this contract. The Contractor shall prepare his own material and equipment takeoff lists as necessary to meet the requirements of this project manual.

C. General design requirements:
   1. All equipment shall conform to requirements specified in Section 01 73 24 – Design Requirements for Non-Structural Components and Non-Building Structures.
   2. Provide lifting lugs for all equipment weighing greater than 50 lb.

1.02 SUBMITTALS

A. As required in Section 01 33 00 – Submittal Procedures and as identified in individual equipment specifications.

1.03 QUALITY ASSURANCE

A. Arrangement:
   1. The arrangement of equipment shown on the drawings is based upon information available to the Owner at the time of design and is not intended to show exact dimensions conforming to a specific manufacturer. The drawings are, in part, diagrammatic, and some features of the illustrated equipment installation may require revision to meet actual submitted equipment installation requirements; these may vary significantly from manufacturer to manufacturer. The contractor shall, in determining the cost of installation, include these differences as part of his bid proposal. Structural supports, foundations, connected piping, valves, and electrical conduit specified may have to be altered to accommodate the equipment actually provided. No additional payment shall be made for such revisions and alterations.

B. References:

1. This section contains references to the documents listed below. They are a part of this section as specified and modified. Where a referenced document cites other standards, such standards are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, has been discontinued or has been replaced.

Reference	Title
ABMA Std 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA Std 11	Load Ratings and Fatigue Life for Roller Bearings
ANSI B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Gray Iron Pipe Flanges and Flanged Fittings, (Classes 25, 125, and 250)
ANSI B18.2.1	Square and Hex Bolts and Screws (Inch Series)
ANSI B18.2.2	Square and Hex Nuts (Inch Series)
ANSI S2.19	Mechanical Vibration – Balance Quality Requirements of Rigid Rotors, Part 1: Determination of Permissible Unbalance, Including Marine Applications

C. Unit Responsibility:

1. The Contractor shall cause equipment assemblies made up of two or more components to be provided as a working unit by the unit responsibility manufacturer, where specified. The unit responsibility manufacturer shall coordinate selection, coordinate design, and shall provide all mechanical equipment assembly components such that all equipment components furnished under the specification for the equipment assembly, and all equipment components specified elsewhere but referenced in the equipment assembly specification, is compatible and operates reliably and properly to achieve the specified performance requirements. Unless otherwise specified, the unit responsibility manufacturer shall be the manufacturer of the driven component equipment in the equipment assembly. The unit responsibility manufacturer is designated in the individual equipment specifications found elsewhere in this project manual. Agents, representatives or other entities that are not a direct division of the driven equipment manufacturing corporation shall not be accepted as a substitute for the driven equipment manufacturer in meeting this requirement. The requirement for unit responsibility shall in no way relieve the Contractor of his responsibility to the Owner for performance of all systems as provided in the General Conditions of the Contract Documents.

D. The Contractor shall ensure that all equipment assemblies provided for the project are products for which unit responsibility has been accepted by the unit responsibility manufacturer(s), where specified. Unit responsibility for related components in a mechanical equipment assembly does not require or obligate the unit responsibility manufacturer to warranty the workmanship or quality of component products not manufactured by them. Where an individual specification requires the Contractor to furnish a certificate from a unit responsibility manufacturer, such certificate shall conform to the content, form and style of Form 43 05 11-C specified in Section 01 99 90, shall be signed by an officer of the unit responsibility manufacturer's corporation and shall be notarized. No other submittal material will be processed until a Certificate of Unit Responsibility has been received and has been found to be satisfactory. Failure to provide acceptable proof that the unit responsibility requirement has been satisfied will result in withholding approval of progress payments for the subject equipment even though the equipment may have been installed in the work.

E. Balance:

1. Unless specified otherwise, for all machines 10 HP and greater, all rotating elements in motors, pumps, blowers and centrifugal compressors shall be fully assembled, including coupling hubs, before being statically and dynamically balanced. All rotating elements shall be balanced to the following criteria:

   a. $U_{per} = 6.015 \frac{GW}{N}$

   b. Where:

      1) U_{per} = permissible imbalance, ounce-inches, maximum
      2) G = Balance quality grade, millimeters per second
      3) W = Weight of the balanced assembly, pounds mass
      4) N = Maximum operational speed, rpm

2. Where specified, balancing reports, demonstrating compliance with this requirement, shall be submitted as product data. Equipment balance quality grade shall be *G* 2.5 (*G* = 2.5 mm/sec) or better in accordance with ANSI S2.19.

PART 2 PRODUCTS

2.01 FLANGES AND PIPE THREADS

A. Flanges on equipment and appurtenances provided under this section shall conform in dimensions and drilling to ANSI B16.1, Class 125. Pipe threads shall conform in dimension and limits of size to ANSI B1.1, coarse thread series, Class 2 fit.

B. Threaded flanges shall have a standard taper pipe thread conforming to ANSI B1.20.1. Unless otherwise specified, flanges shall be flat faced.

C. Flange assembly bolts shall be heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2. Threads shall be Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 2B, ANSI B1.1.

2.02 BEARINGS

A. Unless otherwise specified, equipment bearings shall be oil or grease lubricated, ball or roller type, designed to withstand the stresses of the service specified. Each bearing shall be rated in accordance with the latest revisions of ABMA Methods of Evaluating Load Ratings of Ball and Roller Bearings. Unless otherwise specified, equipment bearings shall have a minimum L-10 rating life of 100,000 hours. The rating life shall be determined using the maximum equipment operating speed.

B. Grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic alemite type.

C. Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60 degrees C and shall be equipped with a filler pipe and an external level indicator gage.

D. All bearings accessible to touch, and located within 7 feet measured vertically from floor or working level or within 15 inches measured horizontally from stairways, ramps, fixed ladders or other access structures, shall either incorporate bearing housings with sufficient cooling to maintain surface temperature at 65 degrees C or less for continuous operation at bearing rated load and a 50 degrees C ambient temperature or shall be provided with appropriate shielding shall be provided that will prevent inadvertent human contact.

2.03 V-BELT ASSEMBLIES

A. Unless otherwise specified, V-belt assemblies shall be Dodge Dyna-V belts with matching Dyna-V sheaves and Dodge Taper-lock bushings, Wood's Ultra V-belts with matching Ultra-V sheaves and Wood's Sure-Grip bushings, or equal.

B. Sheaves and bushings shall be statically balanced. Additionally, sheaves and bushings which operate at a peripheral speed of more than 5500 feet per minute shall be dynamically balanced. Sheaves shall be separately mounted on their bushings by means of three pull-up grub or cap tightening screws. Bushings shall be key seated to the drive shaft.

C. Belts shall be selected for not less than 150 percent of rated driver horsepower and, where two sheaves sizes are specified, shall be capable of operating with either set of sheaves. Belts shall be of the antistatic type where explosion proof equipment is specified.

2.04 PUMP SHAFT SEALS

A. General:

1. Seals for water and wastewater pump shafts shall be either stuffing box or mechanical seals. For industrial wastewater service, or for fluids other than water or municipal wastewater, the recommendations of the seal manufacturer shall be followed for selection of appropriate seals. Unless specified otherwise, stuffing boxes and mechanical seals shall conform to the requirements set forth in this paragraph.

B. Mechanical Seals:

1. Unless otherwise specified in the detailed pump specifications, mechanical seals shall be split mechanical seals requiring no field assembly, other than assembly around the shaft and insertion into the pump. They shall be self-aligning, and self-centering, single seals. They shall be of a nondestructive (nonfretting) type requiring no wearing sleeve for the shaft. Shafts for pumps specified with mechanical seals shall be furnished with no reduction in size through the seal area (no shaft sleeve). Where the detailed specifications call for cartridge instead of split seals, all other requirements of this paragraph apply.
2. Metal parts shall be Type 316 or 316L stainless steel. Springs shall be Hastelloy C, Elgiloy, or other Duplex SS selected for resistance to chloride attack. Rotary faces shall be silicon carbide or chrome oxide. Stationary faces shall be silicon carbide for solids bearing fluid service and carbon for clean water service. Elastomers shall be ethylene propylene or fluorocarbon. Mechanical seals shall be suitable for operation between full vacuum (0 psia) up to 200 percent of the maximum specified operating pressure, but in any event not less than 200 psig.
3. Seal chambers shall be provided with vented solids removal restriction bushings except for enclosed line shaft pumps where the seal barrier fluid is used for line shaft bearing lubrication. The bushing shall both control the amount of flushing water flow and restrict solids and gas accumulation from the seal face area.
4. Candidate seals include:
    a. Chesterton 442 seals provided with Chesterton/SpiralTrac solids removal restriction bushings Version N or D, as recommended by EnviroSeal Engineering Products, Ltd, Nova Scotia, Canada.
    b. AESSEAL RDSX seals with restriction bushing.
    c. John Crane 3710 seals with Type 24SL bushing.
5. Seals on pumps for contaminated water service (sludge, grit, wastewater, scum, reclaimed water, etc.) shall be drilled and tapped for connection of a clean water flushing supply.
6. Seals for all vertical pumps (whether column or volute type) shall be provided with a second flush connection. Vertical pumps shall have a vent valve attached to the mechanical seal to eliminate air from the seal chamber prior to pump start; start-up procedures shall include venting instructions; and for remotely started pumps, the vent system shall be automated. Where specified in the detailed specifications, permissive confirmation automatic vent systems shall be provided.

C. Shaft Packing:

1. Where shaft packing is specified, stuffing boxes shall be tapped to permit introduction of seal liquid and shall hold a minimum of five rows of packing. Stuffing boxes shall be face attached. Stuffing box and shaft shall be suitable for field installation, without machining or other modifications, of the mechanical seal specified in paragraph 2.04 Mechanical Seals for the applicable pump and operating conditions.
2. Unless otherwise specified, lantern rings shall be bronze or Teflon, packing shall be die-molded packing rings of non-asbestos material suitable for the intended service and as recommended by the manufacturer, and glands shall be bronze, two piece split construction. Lantern rings shall be of two-piece construction and shall be provided with tapped holes to facilitate removal. Lantern rings shall be drilled and tapped 1/4 NC-20. The impeller end of the packing on all but line shaft pumps with external source water lubricated bearings shall be fitted with a SpiralTrac, Version P packing protection system as manufactured by EnviroSeal Engineering Products, Ltd, Nova Scotia, Canada.
3. The section of each shaft or impeller hub that extends through or into the stuffing box shall be fitted with a replaceable stainless steel sleeve with a Brinell hardness of not less than 500. The sleeve shall be held to the shaft to prevent rotation and shall be gasketed to prevent leakage between the shaft and the sleeve. Minimum shaft sleeve thickness shall be 3/8 inch.

2.05 COUPLINGS

A. Unless otherwise specified in the particular equipment sections, equipment with a driver greater than 1/2 HP, and where the input shaft of a driven unit is directly connected to the output shaft of the driver, shall have its two shafts connected by a flexible coupling which can accommodate angular misalignment, parallel misalignment and end float, and which cushions shock loads and dampens torsional vibrations. The flexible member shall consist of a tire with synthetic tension members bonded together in rubber. The flexible member shall be attached to flanges by means of clamping rings and cap screws, and the flanges shall be attached to the stub shaft by means of taper lock bushings which shall give the equivalent of a shrunk-on fit. There shall be no metal-to-metal contact between the driver and the driven unit. Each coupling shall be sized and provided as recommended by the coupling manufacturer for the specific application, considering horsepower, speed of rotation, and type of service.

B. Where torque or horsepower capacities of couplings of the foregoing type is exceeded, Thomas-Rex, Falk Steel Flex, or equal, couplings will be acceptable provided they are sized in accordance with the equipment manufacturer's recommendations and sizing data are submitted. They shall be installed in conformance to the coupling manufacturer's instructions.

2.06 GUARDS

A. Exposed moving parts shall be provided with guards which meet all applicable OSHA requirements. Guards shall be fabricated of 14-gage steel, 1/2-13-15 expanded metal screen to provide visual inspection of moving parts without removal of the guard. Guards shall be galvanized after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts. Reinforced holes shall be provided. Lube fittings shall be extended through guards.

2.07 CAUTION SIGNS

A. Equipment with guarded moving parts which operates automatically or by remote control shall be identified by signs reading "Caution - Automatic Equipment May Start At Any Time". Signs shall be constructed of fiberglass material, minimum 1/8 inch thick, rigid, suitable for post mounting. Letters shall be white on a red background. The sign size and pattern shall be as shown on the drawings. Signs shall be installed near guarded moving parts.

2.08 GAGE TAPS, TEST PLUGS AND GAGES

A. Gage taps shall be provided on the suction and discharge sides of pumps, blowers and compressors. Pressure and vacuum gages shall be provided where specified. Gage taps, test plugs, and gages shall be as specified in Division 40.

2.09 NAMEPLATES

A. Nameplates shall be provided on each item of equipment and shall contain the specified equipment name or abbreviation and equipment number. Equipment nameplates shall be engraved or stamped stainless steel and fastened to the equipment in an accessible and visible location with stainless steel screws or drive pins.

2.10 LUBRICANTS

A. The Contractor shall provide for each item of mechanical equipment a supply of the required lubricant adequate to last through the specified commissioning period. Lubricants shall be of the type recommended by the equipment manufacturer and shall be products of the Owner's current lubricant supplier. The Contractor shall limit the various types of lubricants by consolidating them, with the equipment manufacturer's approval, into the least number of different types. Not less than 90 days before the date shown in his construction schedule for starting, testing and adjusting equipment (Section 01 45 20), the Contractor shall provide the Owner with three copies of a list showing the required lubricants, after consolidation, for each item of mechanical equipment. The list shall show estimated quantity of lubricant needed for a full year's operation, assuming the equipment will be operating continuously.

2.11 ANCHOR BOLTS

A. Anchor bolts shall be designed for lateral forces for both pullout and shear in accordance with the provisions of Section 05 05 23. Unless otherwise stated in the individual equipment specifications, anchor bolt materials shall conform to the provisions of Section 05 05 23.

2.12 SPARE PARTS

A. Spare parts, wherever required by detailed specification sections, shall be stored in accordance with the provisions of this paragraph. Spare parts shall be tagged by project equipment number and identified by part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration, such as ferrous metal items and electrical components, shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with a hinged wooden cover and locking hasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.

PART 3 EXECUTION

3.01 GENERAL

1. Installation of equipment accessories included in this section shall be as recommended by the equipment manufacturer unless otherwise specified in the individual eqsubuipment specification section.

END OF SECTION

SECTION 43 05 13

RIGID EQUIPMENT MOUNTS

PART 1 GENERAL

1.01 SUMMARY

1. Section includes: This Section specifies requirements for rigid equipment mounts. Rigid equipment mounts consist of equipment pads, equipment anchors, and mounting plates (baseplates, soleplates, or fabricated steel frames) set in grout.
2. Conform to the requirements specified in the Equipment Mounting Schedule (Part 4 of this Section) or equipment mounting configuration requirements specified in individual equipment specifications . Where equipment mounting requirements are not specifically identified, the default mounting configuration for equipment consists of Pad Anchored Equipment Pads per Standard Detail D01007 with adhesive dowels anchoring the equipment pad to the foundation, equipment and driver mounted on a common mounting plate, mounting plate leveled within 0.005 inch/foot, equipment anchored to the equipment pad with cast-in-place equipment anchors per Standard Detail D01002, equipment anchor sleeve length is 10 times the bolt diameter, and the mounting plate is grouted in position using non-shrink grout.
3. If a conflict exists between this Section and requirements of individual equipment manufacturers, the more restrictive requirements shall prevail.
4. Requirements for non-rigid equipment mounts (vibration isolation systems) are specified in the associated equipment specification. Furnish rigid equipment mounts conforming to the requirements of this Section for the equipment pad and other equipment mounting components supporting the vibration isolation system.

1.02 RELATED SECTIONS

A. This Section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 61 45 – Area Exposure Designations
   2. Section 01 73 23 - Structural Design and Anchorage Requirements for Nonstructural Components and Non-Building Structures
   3. Section 01 99 90 - Reference Forms
   4. Section 03 60 00 – Grouting
   5. Section 05 05 20 – Anchor Bolts
   6. Section 09 90 00 – Painting and Coating
   7. Section 43 05 11 – General Requirements for Equipment
   8. Section 43 05 14 – Machine Alignment
   9. Section 43 05 17 – Vibration and Critical Speed Limitations

1.03 REFERENCES

A. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section prevail.

Reference	Title
ACI 318, Appendix D	Building Code and Commentary, Anchorage to Concrete
HI 14.3	Rotodynamic Pumps –for Design and Application
HI 14.4	Rotodynamic Pumps –for Installation, Operation and Maintenance
API RECOMMENDED PRACTICE 686	Recommended Practices for Machinery Installation and Installation Design
ASCE 7	Minimum Design Loads and Associated Criteria for Buildings and Other Structures
ASME B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ASTM E329	Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F1554	Anchor Bolts, Steel, 36, 55 and 105 ksi Yield Strength
MIL-PRF-907E	Anti-Seize Thread Compound, High Temperature
SSPC	Society for Protective Coatings Specifications, Vol. 2
IBC	International Building Code (including local amendments)

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:

1. Baseplate: A mounting plate configured with a top plate and a perimeter edge of the mounting plate that is below the top plate. Baseplates have a cavity between the top plate and a horizontal plane at the bottom edge of the perimeter of the mounting plate.
2. Soleplate: A machined or pre-formed mounting plate with a uniform horizontal surface across the entire underside of the mounting plate, excepting shear lugs/keys, grout pour holes, vent holes, and attachment hardware (nuts, bolts, tapped holes, etc.). Soleplates have a top plate but lack the perimeter bottom edge that extends below the underside of the top plate that is a defining feature of baseplates.
3. Fabricated Steel Frame: An equipment mounting plate constructed of rolled steel shapes and plates welded into a frame. Fabricated steel frames do not have top plates.
4. Equipment Pad: Concrete foundation (block or slab) supporting and elevating mounting plates above the supporting structural floor slab or local grade.
5. Mounting Pads: Milled/machined areas of baseplates, soleplates, and fabricated steel frames where the feet or mounting surfaces of mounted equipment and drivers are bolted to the baseplate, soleplate, or fabricated steel frame.
6. Leveling Blocks: Steel blocks temporarily placed under baseplates, soleplates, or fabricated steel frames at leveling positions (at equipment anchors) for the purpose of leveling baseplates, soleplates, or fabricated steel frames prior to grouting.

7. Shims: Thin stainless steel plates of uniform thickness used for fine adjustment of level. Shims are used on top of leveling blocks for mounting plate leveling or used between equipment drivers and baseplates, soleplates, or fabricated steel frames for equipment alignment.
8. Wedges: Pairs of uniformly tapered metal blocks that are stacked with the tapered surfaces reversed (relative to the other wedge) so that the top and bottom surfaces of the wedges are parallel. Wedges are used between equipment pads and baseplates, soleplates, or fabricated steel frames for the purpose of leveling mounting plates.
9. Mounting Stud: Threaded rod or bolts anchored to baseplates, soleplates, or fabricated steel frames for the purpose of mounting equipment or ancillary devices onto baseplates, soleplates, or fabricated steel frames.
10. Reinforcement Dowels or Reinforcement Hooks: Steel reinforcement rods embedded in concrete, across a cold joint, for the purpose of transferring loads or force across the joint.
11. Leveling Position: A location on the top of a concrete equipment pad where leveling tools and equipment will be temporarily installed or used for the purpose of leveling baseplates, soleplates, and fabricated steel frames prior to grouting.
12. Grout Manufacturer: Refers to the manufacturer of the grout product used for installation of rigid equipment mounts.
13. Grout Manufacturer's Technical Representative(s): Refers to the technical representative(s) of the Grout Manufacturer. The Grout Manufacturer's Technical Representative shall not be an employee of the Contractor.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation Meetings:
   1. Conduct a pre-installation meeting with the Construction Manager's representative prior to installation of equipment mounts.
   2. Schedule a pre-installation meeting for the equipment mounts associated with each system or group of identical equipment items.
   3. Where equipment anchors are cast in the floor slab or foundation, schedule the pre-installation meeting prior to pouring the floor slab or foundation.

1.06 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this Section, including addendum updates, (referenced sections need not be included for this Section) with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from specification requirements. Check marks denote full compliance with a paragraph as a whole. Underline each deviation and denote with a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. Mark copies of this Section with the specification number and equipment number for inclusion (filing) with submittal materials furnished for individual equipment specifications.

3. Name, employer, and a copy of the employee's Qualified Millwright card or other equivalent certificate of journeyman qualifications for millwrights who will install rigid equipment mounts, as specified in paragraph 3.02, Leveling.
4. Certificates or other documentation issued by the epoxy grout manufacturer that demonstrates that the grout manufacturer's technical representative has been factory trained on installation of epoxy grout for equipment mounts, as specified in paragraph 1.07 Quality Control by Contractor.
5. List of Contractor's equipment installation staff that have completed epoxy grout manufacturer's grout installation training specified in paragraph 3.03, Manufacturer's Services.
6. Shop drawings for equipment pads, equipment anchors, and baseplate, soleplate or fabricated steel frame depict size and location of equipment pads and reinforcement; equipment drains; equipment anchor, size, location, and projection; expansion joint locations; grout formwork; elevation of top of grout and grout thickness; elevation of top of baseplate, soleplate, or mounting block; size and location of electrical conduits; and any other equipment mounting features embedded in equipment pads. Shop drawings for equipment pads, equipment anchors, and baseplate, soleplate, or fabricated steel frames to be numbered and marked (specification number and equipment number) for inclusion (filing) with the associated equipment submittal requirements.

B. Informational Submittals:
1. Procedures: Section 01 33 00
2. Submit equipment anchor calculations demonstrating compliance with paragraph 2.04, Equipment Anchor Design. Submit equipment anchor calculations with submittal information specified in the associated equipment specification.
3. Results of grout strength tests, as specified in paragraph 3.02, Grouting.
4. Completed Rigid Equipment Mount Installation Inspection Checklist Forms (43 05 13-A), as specified in paragraph 3.03, Manufacturer's Services.

1.07 QUALITY ASSURANCE

A. Quality Control By Contractor:
1. Except where union rules require installation by another trade, all machinery to be mounted and leveled by journeyman millwrights.
2. Epoxy grout installation performed by employees that have completed the epoxy grout manufacturer's grout installation training specified in this Section.
3. Provide the services of an independent testing laboratory that complies with the requirements of ASTM E329. Testing laboratory to sample and test materials installed as part of rigid equipment mounts specified in this Section. Testing laboratory services costs borne by the Contractor.
4. Where epoxy grout is specified for bedding mounting plates, furnish the services of a grout manufacturer's technical representative who has been factory trained by the grout manufacturer. The grout manufacturer's technical representative performs training and quality control for epoxy grout installation for rigid equipment mounts as specified in paragraph 3.03, Manufacturer's Services.

B. Special Inspection for Equipment Anchors:
   1. Equipment anchors shall comply with special inspection requirements specified in Section 05 05 20.

PART 2 PRODUCTS

2.01 GENERAL

A. Configure rigid equipment mounts as specified in the Equipment Mounting Schedule (See Part 4 of this specification) or as specified in individual equipment specifications. Equipment mounting configuration requirements in individual equipment specifications govern over configuration requirements specified in the Equipment Mounting Schedule. In the absence of equipment mounting configuration requirements in either of these locations, mount equipment per the default requirements specified in paragraph 1.01.

B. Pumps installed in accordance with this Section, HI 14.3, and HI 14.4.

2.02 MATERIALS FOR EQUIPMENT MOUNTING

A. Equipment pads: Reinforced concrete as specified in Standard Details D01006 and D01009.

B. Mounting Plates: Cast iron, cast steel, plate steel, fabricated steel frame, polymer concrete, or FRP as specified in the equipment specification.

C. Grout type for equipment mounting as specified in the Equipment Mounting Schedule or in individual equipment specification.
   1. Epoxy Grout for Equipment Mounting: Where epoxy grout is specified in the Equipment Mounting Schedule or in individual equipment specifications, provide Epoxy Grout for Equipment Mounting as specified in Section 03 60 00. Where the term epoxy grout is used in the context of details and specifications for equipment mounting it means Epoxy Grout for Equipment Mounting as specified in Section 03 60 00.
   2. Cementitious Nonshrink Grout: Where non-shrink grout is specified in the Equipment Mounting Schedule or in individual equipment specifications, Cementitious Non-shrink Grout, specified in Section 03 60 00, may be used for setting bearing surfaces of baseplates, soleplates, or fabricated steel frames. Where the term non-shrink grout or cementitious grout is used in the context of details and specifications for equipment mounting it means Cementitious Non-shrink Grout as specified in Section 03 60 00.

D. Equipment anchors: Materials per the following table and per the area exposure condition where the equipment is installed. Section 01 61 45 specifies area exposure conditions.

Area Exposure	Equipment Anchor Materials
Indoor, Dry	316 Stainless, ASTM F593, Cond. CW
Indoor, Wet	316 Stainless, ASTM F593, Cond. CW
Outdoor	304 Stainless, ASTM F593, Cond. CW
Submerged, Immersed	316 Stainless, ASTM F593, Cond. CW
Process Corrosive	316 Stainless, ASTM F593, Cond. CW

Area Exposure	Equipment Anchor Materials
Chemical Corrosive	316 Stainless, ASTM F593, Cond. CW

E. Anchor sleeves: Flexible polyurethane foam, steel cylinder/tubes, or corrugated/ribbed plastic sleeves.

F. Epoxy Primer: High-strength, lead free, chrome free, rust inhibiting two-component epoxy primer specifically designed for use on metal substrates and in conjunction with epoxy grout. Bond strength to sandblasted metal not less than 1500 psi.
   a. ITW Performance Polymer MS-7CZ primer
   b. Approved equal.

G. Anti-seize/Anti-galling compound: Molybdenum disulfide and graphite combination in aluminum complex base grease conforming to MIL-PRF-907E.
   a. Jet Lube 550 by Jet Lube, Inc.
   b. E-Z Break by LA-CO
   c. or approved equal.

2.03 EQUIPMENT PADS

A. Minimum dimensions for equipment pads are shown on structural drawings where a minimum equipment pad mass is required for vibration dampening/control.

B. Equipment Pad Drainage:
   1. Furnish equipment pads with 2-inch drains.
   2. Locate equipment pad drains at drainage outlets from equipment or mounting plates
   3. Route equipment drainage outlets or mounting plate drainage outlets to equipment pad drains
   4. Route equipment pad drains to the floor drainage collection system.
   5. Drainage piping for equipment pads shall be routed below the finished floor elevation.
   6. Exposed drain lines mounted on the floor are not acceptable.

2.04 EQUIPMENT ANCHORS:

A. Equipment Anchors:
   1. All thread rod with heavy hex welded nuts, heavy hex bolts, post-installed anchors (wedge, sleeve, undercut, expansion, and adhesive anchors), or adjustable canister anchors as specified in the Equipment Mounting Schedule or in individual equipment specifications.
   2. Bolt length as required for the specified embedment and sleeve length. Reduce equipment anchor sleeve length as necessary to fit within finished height of equipment pad if equipment pad height is insufficient to provide specified equipment anchor sleeve length. Unified Coarse Thread Series per ASME B1.1.
   3. Post-installed anchors (wedge, sleeve, undercut, expansion, and adhesive anchors) conforming to the requirements of Section 05 05 20.

4. Adjustable canister anchors consist of cast-in-place pre-manufactured adjustable anchor inserts. Provide a minimum of 6 inches of vertical bolt height adjustment and lateral adjustment of the anchor bolt while maintaining the anchor bolt in a true vertical orientation.
    a. Jakebolts as manufactured by Unisorb
    b. Heavy Duty Adjustable Anchors as manufactured by Deco
    c. Rowan Adjustable Canister Anchor Bolt
    d. or approved equal.

B. Equipment Anchor Design:
1. Size (diameter) of anchors for clamping/fastening mounting plates to equipment pads determined by the equipment manufacturer.
2. Comply with building codes listed in Section 01 73 24 for equipment anchor size, embedment, and edge distance. Provide equipment anchors that are sufficient to resist the maximum lateral and vertical forces specified in Section 01 73 23.
3. Resistance to lateral (horizontal) loads based on the static friction between the mounting plate and its supporting grout pad. Include the clamping force applied by equipment anchors and the weight of the equipment for calculating static friction resistance to lateral loads. Do not include lateral (shear) loading on equipment anchors or adhesion between mounting plates and supporting grout in lateral loading resistance calculations.
4. Furnish equipment anchor calculation submittals for pressure vessels and valve racks supplied as part of Section 43 31 13.13, tanks supplied as part of Section 43 41 43.13, chlorine containment vessel supplied as part of Section 46 31 12, inclined plate settler supports supplied as part of Section 46 63 76, and valve racks and membrane modules supplied as part of Section 46 61 33.
5. Equipment anchor calculations sealed by a registered structural or civil engineer licensed in the State of Arizona.

C. Equipment Anchor Tension:
1. Unless alternate bolt torque/tension requirements are specified by the equipment manufacturer, tighten equipment anchors to provide a final clamping force that produces a tensile stress of 15,000 psi in each equipment anchor. Tighten adjustable canister anchors to the manufacturer's maximum safe working load. Tighten post-installed anchors to manufacturer's recommendations.
2. Bolt torque values required to produce the specified bolt tension based on well lubricated plain finish national coarse thread bolts are presented in the following table. Revise bolt torque values per equipment manufacturer's recommendations for alternate thread patterns, thread lubrication, bolt material, or bolt finish.

Bolt Diam. (in)	3/8	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4	1-1/2
Final bolt torque for 15,000 psi bolt stress (ft*lbs)	8	15	30	50	80	125	180	250	400

D. Anchor Sleeves:
1. Provide sleeves for equipment anchors as specified in the Equipment Mounting Schedule or in individual equipment specifications.

2. Adjust equipment anchor length/embedment depth shown in Standard Detail D01002 if sleeves are not required.
3. Sleeves may be installed at the Contractor's option if not specified in the Equipment Mounting Schedule or in individual equipment specifications provided they do not interfere with specified embedment lengths.
4. Fill steel cylinders/tubes and ribbed plastic sleeves with a flexible room temperature vulcanizing (RTV) sealant prior to embedment/installation.

2.05 MOUNTING PLATES

A. General:
1. Round edges of surfaces of baseplates, soleplates, and fabricated steel frames that bear on grout to a radius of not less than 0.25 inch.
2. Round perimeter corners of baseplates, soleplates, or fabricated steel frames to a radius of not less than 2.0 inches to avoid producing stress risers on the grouted foundation.
3. Provide grout pouring holes (minimum 4 inches in diameter for epoxy grout, minimum 2.5 inches in diameter for cementitious non-shrink grout) and air release holes in all baseplates and soleplates.
4. Provide grout relief or vent holes (minimum 1 inch in diameter) in all baseplates and soleplates.
5. Drill mounting holes for equipment anchors through baseplates, soleplates, and fabricated steel frames. Open slots or burned out holes for equipment anchors are not permitted.
6. Provide acorn nuts welded to the underside of the baseplate or soleplate or nuts welded to the underside of the baseplate or soleplate and plugged with cork, plastic plugs or grease where terminations to baseplates and soleplates are required.
7. Where fasteners terminate only into the baseplate, soleplate, or fabricated steel frame, threaded lengths (tapped or embedded in mounting plates) shall be not less than the bolt diameter.
8. Where baseplates, soleplates, or fabricated steel frames are leveled using jackscrews, tap jackscrew threads in thickened pads or otherwise in sufficient metal to provide ease in adjusting level.
9. Mill mounting pads and/or mounting surfaces of baseplates, soleplates, and fabricated steel frames flat and coplanar within 0.0005 inch per foot in all directions after all welding and stress relieving.
10. Pre-grout baseplates prior to milling.
11. Baseplates, soleplates, and fabricated steel frames provide common support for the equipment and driver (and flywheel, if one is specified).
12. For equipment with drivers 20 horsepower and greater, provide transverse alignment (horizontal) positioning jackscrews for alignment of equipment drivers on horizontal surfaces of baseplates, soleplates, and fabricated steel frames.
13. Provide alignment/positioning jackscrews in perpendicular directions in a horizontal plane at the mounting position for each corner or foot of the equipment driver. (Additional jackscrews provided for transverse alignment of the flywheel, if flywheels are specified in the equipment specification.)

14. Where specified in individual equipment specifications; baseplates, soleplates, and fabricated steel frames fitted with RK Fixators as manufactured by Unisorb, or approved equal.
    a. Fixators installed at mounting surfaces for drivers.
    b. Fixators consist of a three-piece wedge leveling adjustment device incorporating a spherical washer assembly to provide true level height adjustment at each mounting surface for the equipment driver.

B. Fabricated Steel Frames:
    1. Fabricated steel frames consist of structural steel shapes welded to form mounting plates.
    2. Fabricated steel frames to be rectangular in shape, excepting fabricated steel frames for centrifugal refrigeration machines and pumps which may be T- or L-shaped to accommodate the equipment driver and accessories.
    3. Fabricated steel frames for split case pumps include supports for suction and discharge elbows, if required by the specified configuration.
    4. Perimeter members consist of I-beams or C-channel with a minimum depth equal to 1/10 of the longest dimension of the fabricated steel frame. Beam depth need not exceed 14 inches provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer.
    5. Fabricated steel frames furnished with thickened steel mounting pads welded to the fabricated steel frame for bolting equipment to the mounting plate.
    6. Sandblast surfaces of fabricated steel frames in contact with grout to white metal per SSPC SP-5.
    7. Apply a high-strength epoxy primer as specified in paragraph 2.02F within 8 hours of sandblasting the fabricated steel frame.

C. Baseplates:
    1. Baseplates may be welded steel, cast steel, or cast iron with thickened mounting pads for bolting equipment to the baseplate.
    2. Provide internal stiffeners on all cast and fabricated baseplates. Stiffeners designed to allow free flow of grout from one section of the baseplate to another.
    3. Provide a minimum 2 inches high by 6 inches wide opening in cross bracing and stiffeners for grout flow between sections of the baseplate.
    4. All welds continuous and free from skips, blowholes, laps and pockets.
    5. Pre-grout baseplates at the factory after all welding has been completed and prior to machining the mounting pads on the baseplate. Pre-grout baseplates in the field if they have not been pre-grouted at the factory. Remove the equipment from the baseplate, invert the baseplate, and pre-grout as specified in this Section.
    6. Prior to pre-grouting, sandblast the underside of baseplates to white metal per SSPC SP-5.
    7. Complete pre-grouting within 8 hours of sandblasting.
    8. Fill the underside of the baseplate to the bottom edges of the baseplate.
    9. Seal cast iron baseplates to prevent surface bleeding prior to shipment to the project site.

D. Plate Steel Soleplates:
   1. Not less than 1.0 inch thick for equipment with drivers greater than 30 horsepower.
   2. Furnished with grout keys/lugs or stiffeners on the underside of the soleplate.
   3. Flat uniform horizontal surface on underside of plate steel soleplates, excepting grout keys, grout pour holes, vent holes, and attachment hardware (nuts, bolts, tapped holes, etc.).
   4. Prior to milling the mounting pads for equipment or mounting surfaces, scribe the words “THIS SIDE DOWN”, using welding rod material, on the underside of plate steel soleplates , .
   5. Plate steel soleplates without grout pouring holes are acceptable provided that no dimension of the soleplate (width or length) exceeds 18 inches.
   6. Sandblast surfaces of plate steel soleplates in contact with grout to white metal per SSPC-SP-5, prior to shipment to the project site.
   7. Apply a high-strength epoxy primer as specified in paragraph 2.02 within 8 hours of sandblasting the underside of plate steel soleplates.
   8. Where equipment is fabricated or cast with feet or mounting surfaces that are not fastened to a common baseplate or soleplate, as in dry-pit bottom-suction pumps, the equipment may be supported on individual concrete piers or equipment pads in lieu of mounting on a common equipment pad and soleplate. In such instances, support the equipment at the feet or mounting surfaces on individual plate steel soleplates. Level individual plate steel soleplates and grout into place on the individual piers or equipment pads as specified in this Section. Where multiple soleplates are installed to support one piece of equipment, soleplates shall be coplanar within 0.002 inch/foot.

E. Polymer Concrete Soleplates:
   1. Pre-cast soleplates consisting of polymer concrete with stainless steel inserts for equipment mounting.
   2. Mounting surfaces shall be coplanar within 0.002 inch/foot.
   3. Furnished with a uniform horizontal surface over the entire underside of the mounting plate, excepting grout keys, grout pour holes and vent holes.
      a. PoxyBase as manufactured by Basetek
      b. Chembase as manufactured by Goulds
      c. Approved equal.

F. Corrosion Resistant FRP Baseplates:
   1. Pre-formed fiber reinforced plastic fabrications.
   2. Product of the manufacturer of the equipment that is mounted on the baseplate.

PART 3 EXECUTION

3.01 PREPARATION

A. Concrete Equipment Pad Preparation:
   1. Roughen the top of the equipment pad after the concrete has reached its 28-day compressive strength.
   2. Remove all laitance and defective or weak concrete.

3. Roughen surface profile to 0.25 inch amplitude, minimum.
4. Expose broken aggregate without dislodging unbroken aggregate from the cement matrix and without fracturing concrete and aggregate below the concrete surface.
5. Roughen using a light-duty (15 pounds or less), hand-held chipper with a chisel type tool.
6. Abrasive blast, bush-hammer, jack hammers with sharp chisels, heavy chipping tools, or needle gun preparation of concrete surfaces to be grouted are not acceptable.
7. Demonstrate removal of defective or weak concrete to the Construction Manager prior to leveling.
8. Chip the surface of the concrete such that the final elevation of the equipment pad provides the grout manufacturer's recommended thickness between the surface of the equipment pad and the lower baseplate flange, underside of the soleplate, or underside of the fabricated steel frame.
9. Remove all dust, dirt, chips, oil, water, and any other contaminants and protect the surface with plastic sheeting until grout is installed.
10. Protect concrete equipment pad surfaces that have been finished smooth and level for use as leveling positions. Protect from damage during chipping activities. Alternatively, leveling positions may be restored on chipped surfaces. Restore leveling positions by installing leveling blocks or leveling plates for jackscrews on a high compressive strength epoxy putty (Philadelphia Resins, Phillybond Blue 6A, or equal). Leveling blocks and leveling plates installed level on the epoxy putty.

B. Grout Form Construction:
1. Design forms for a minimum of 6 inches hydrostatic head above the final elevation of the grout and manufacturer's recommendations for form edge clearance for intended pour scheme, but not less than two inches.
2. Install grout expansion joints at 4 to 6 foot intervals, perpendicular to the centerline of baseplates. Design expansion joints in accordance with the grout manufacturer's written instructions.
3. Coat forms with three coats of paste wax on all areas of the forms that will be in contact with the grout.
4. Wax forms before assembly.
5. Prevent accidental application of wax to surfaces where the grout is to bond.
6. Remove any foreign material, such as oil, sand, water, wax, grease, etc., from concrete surfaces that will contact grout before forms are installed.
7. Forms must be liquid tight. Seal any open spaces or cracks in forms, or at the joint between forms and the foundation using sealant, putty, or caulking compound.
8. Chamfer vertical and horizontal edges of the grout with 45-degree chamfers as specified in equipment pad details. Locate 45-degree perimeter chamfer strips at the final elevation of the grout.
9. Match chamfers in concrete portions of the equipment pad.
10. Install block outs at all leveling positions to allow removal of leveling equipment and leveling nuts to be backed off after the grout has cured.
11. Coat jackscrews with a light oil or other acceptable bond-breaking compound prior to grouting.
12. Seal equipment anchor sleeves to protect the sleeved length of the anchor from contact with grout.

13. Wrap exposed portions of equipment anchors with duct tape to protect them from grout splatter and to prevent bonding to grout.

C. Mounting Plate Preparation:
   1. Roughen the underside of soleplates and fabricated steel frames and wipe with a residue-free solvent as recommended by the epoxy primer manufacturer before placement of the baseplate, soleplate, or fabricated steel frames on the equipment pad for leveling. Roughen surfaces of mounting plates that will be in contact with grout by power tool cleaning. Cleaning performed by power wire brushing, power sanding, power grinding, power tool chipping or power tool descaling. Impart a minimum profile of 1.0 mil.
   2. Prior to placement on the equipment pad for leveling, roughen exposed grout surfaces of pre-grouted baseplates and wipe with a residue-free solvent as recommended by the manufacturer of the epoxy grout used for pre-grouting.
   3. Prepare the underside of corrosion-resistant FRP baseplates and polymer concrete baseplates per the baseplate manufacturer's recommendations and prior to placement of the baseplate on the equipment pad for leveling.
   4. Grouting for installation of mounting plates on equipment pads completed prior to connecting any field piping or electrical and instrumentation systems.
   5. Unless the Construction Manager accepts an alternate installation procedure in writing, baseplates, soleplates, and fabricated steel frames leveled and grouted with the equipment removed.

3.02 INSTALLATION

A. Leveling:
   1. Except where union rules require installation by another trade, all equipment and machinery mounted and leveled by a Qualified Millwright.
   2. Use precision surveying equipment for leveling.
   3. Machinists' spirit levels will not be permitted for leveling purposes for any baseplate, soleplate, or fabricated steel frame with a plan dimension greater than 4 feet.
   4. Baseplates, soleplates, and fabricated steel frames leveled to the tolerance specified in the Equipment Mounting Schedule, in the individual equipment specification, or as otherwise required by the equipment manufacturer, if more stringent.
   5. Apply an anti-seize or anti-galling compound, specified in paragraph 2.02, to all equipment anchor threads prior to beginning baseplate, soleplate, or fabricated steel frame leveling.
   6. Level all baseplates, soleplates, and fabricated steel frames against steel surfaces (jackscrew plates, leveling blocks, leveling nuts, support plates, or other steel surfaces). Use of other materials for leveling purposes is strictly and specifically prohibited.
   7. Use stainless steel leveling blocks and shims, steel wedges, or jackscrews bearing on leveling plates.
   8. Leveling nuts may be used for leveling baseplates, soleplates, and fabricated steel frames weighing less than 200 pounds (inclusive of the weight of the equipment if leveled with the equipment on the mounting plate).
   9. Leveling blocks shall be stainless steel, 4 inches square and 1.5 inches thick with an open-ended slot terminating in the center for the equipment anchor.

10. Machine leveling blocks flat on all horizontal surfaces and place under the baseplate or soleplate at each equipment anchor.
11. Provide pre-cut stainless steel shims, slotted for removal after grouting. Coat leveling blocks and shims with a light oil just prior to beginning the leveling and grouting work. Place shims so the tabs on the shims are easily accessible.
12. Clamp baseplates, soleplates, or fabricated steel frames in position (after leveling) by installing the equipment anchor nuts and washers.
13. Apply bolt tension to fix the position of mounting plates during grouting (30 to 60 percent of the final clamping force applied to clamp the mounting plate to the equipment pad).
14. Prior to grouting, verify that the correct level and position of the baseplate, soleplate, or fabricated steel frame has been maintained after clamping it to the equipment pad.

B. Grouting:
1. Adjust ambient temperature to maintain mounting plate, foundation, and grout temperatures to grout manufacturer's recommended temperature.
2. Mix grout for equipment mounting in accordance with the grout manufacturer's written recommendations.
3. Place epoxy grout using a method that avoids air entrapment.
4. Place grout at one end of the baseplate or soleplate and work grout toward the opposite end to force the air out from beneath the baseplate or soleplate.
5. Pour grout through a head box into grout pouring holes.
6. When the head box is moved to the next grout hole, place a 6 inch standpipe over the grout hole and fill with grout.
7. Pour grout to the top of the lower flange of the perimeter I-beams or C-channel of fabricated steel frames.
8. Pour grout at least 0.125 inch but not more than 0.5 inch above the bottom or underside of the perimeter edge of a baseplate or soleplate.
9. Use of vibrating tools and/or jarring (rapping or tapping) forms to facilitate grout flow is not permitted during placement of epoxy grout.
10. Never allow the grout in the head box to fall below the top of the baseplate or soleplate once the grout has made contact with the baseplate or soleplate.
11. Grout placement applied in one continuous pour, until all portions of the space beneath the baseplate, soleplate, or fabricated steel frame have been filled.
12. Prepare subsequent batches of grout prior to depleting the preceding batch.
13. Maintain grout height in standpipes after the space under the baseplate, soleplate, or fabricated steel frame has been filled.
14. When the grout has started to take an initial set (typically this is determined by a noticeable increase in temperature and no flow of grout at the vent holes) remove the standpipes and clean excess grout from all surfaces.
15. Check for leaks throughout grout pours. Repair leaks immediately to prevent formation of voids.
16. Check baseplate, soleplate, or fabricated steel frame level and elevation before the grout sets.
17. Cure grout in accordance with the grout manufacturer's written instructions.

18. Collect at least one grout sample from each grout pour. Where specified in the individual equipment specifications, collect a grout sample from the grout pour for each equipment pad.
    a. Place samples in a cylinder of sufficient size to yield three 2-inch cubes as test samples.
    b. Label samples with project name, date, time, the equipment number, and ambient temperature at the time of placement.
    c. Place samples next to the foundation of the equipment being grouted and cure for 48 hours.
    d. Test grout samples in accordance with the grout manufacturer's recommendations.
    e. Grout samples tested by the independent testing laboratory specified in paragraph 1.07 Quality Control by Contractor.
    f. Report test results directly to the Construction Manager.

C. Completion:
    1. Upon acceptance by the Construction Manager and the equipment manufacturer's representative and after the grout has reached sufficient strength, remove grout forms and block outs at leveling positions. Remove leveling blocks and shims or wedges and support plates. Back off leveling nuts and jack screws to allow the grout to fully support the baseplate, mounting block, or soleplate. Take care not to damage the grout during removal of extended shimming material or leveling equipment and tools.
    2. Tighten equipment anchor nuts using calibrated indicating torque wrenches, to develop the full bolt tension specified in paragraph 2.04 Equipment Anchor Tension.
    3. Tighten equipment anchor nuts in increments of not more than 25 percent of the final torque value in an alternating pattern to avoid stress concentration on the grout surface. After tightening equipment anchor nuts to final values, apply additional wax, grease, or mastic to all exposed portions of the equipment anchor beneath the baseplate, soleplate, or mounting block.
    4. After applying additional wax or mastic to exposed portions of equipment anchors and tightening to final torque values, fill and point block outs (pockets) for access to leveling nuts, leveling blocks, shims, or wedges with the grout material installed under baseplates, soleplates, or fabricated steel frames. Remove jackscrews and fill holes in the baseplate, soleplate, or fabricated steel frame with a flexible sealant (silicone rubber) or a short cap screw.
    5. Check for baseplate, soleplate, or fabricated steel frame movement (soft foot) by individually loosening and re-tightening each equipment anchor. Measure and record vertical movement at each equipment anchor during loosening and retightening. Measure vertical movement using a magnetic-based dial indicator on the baseplate, soleplate, or fabricated steel frame referenced to the epoxy grout surface of the equipment pad, or other approved method. Vertical movement exceeding 25 micrometers (0.001 inch) indicates a soft foot condition. Soft foot conditions are sufficient cause for removal and reinstallation of grout and baseplates, soleplates, or fabricated steel frames.

6. Check for grout voids by tapping along the upper surfaces of the baseplate, soleplate, or mounting block. Mark grout voids. A grout void is sufficient cause for removal and reinstallation of grout and baseplate, soleplate, or fabricated steel frame. At the discretion of the Construction Manager, grout voids may be repaired as specified in Chapter 5, Section 3.16 of API RP 686.

D. Piping Connections:
   1. Anchor piping connecting to flexible connections and/or expansion joints such that the intended function of these connections/joints is maintained in the piping system without imposing strain on the equipment connections.
   2. Where an equipment manufacturer's installation requirements include a rigid connection between the machine and connecting piping systems, delete any flexible coupling (including equipment connection fittings) shown on the drawings and install the equipment in the following manner, in lieu of installing the flexible coupling:
      a. Install equipment pad as shown in the detail specified in the Equipment Mounting Schedule or in the individual equipment specification.
      b. Install the baseplate, soleplate, or fabricated steel frame supporting the equipment and grouted in place as specified in this Section.
      c. Install and align the equipment in place as specified in Section 43 05 14.
      d. Install and align piping between equipment connections and field piping without welding one of the joints for one section of pipe between the equipment connection and the field piping and all valving. All flanged joints bolted up and pressure-tested.
      e. All piping must be fully supported by supports designed to accept their full weight and thrust forces.
      f. Install the final section of piping. Align the final section of pipe with the equipment and field connections without the use of jacks, chain falls, or other devices to force it into alignment.
      g. Do not weld the final piping joints until after the previous steps have been completed and accepted by the Construction Manager.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Services
   1. Epoxy Grout Training: Prior to commencing rigid equipment mount installation work on equipment pads, furnish the services of a grout manufacturer's technical representative to conduct a training school for the workers who will be using epoxy grout for rigid equipment mount installations. Epoxy grout training school duration to be not less than 4 hours duration and covers all aspects of using the products, including form construction for each equipment installation, surface preparation, mixing, application, void prevention/elimination, and clean up. This requirement does not relieve the Contractor of overall responsibility for this portion of the work. Epoxy grout manufacturer to furnish a list of school attendees who have been satisfactorily trained to perform epoxy grout installation for equipment mounting.

2. Epoxy Grout Quality Control: The epoxy grout manufacturer's technical representative provides quality control services for equipment mounted with epoxy grout. The epoxy grout manufacturer's technical representative must be present (on site) to inspect and verify that the installation personnel have successfully performed surface preparation, epoxy grout application, and Quality Control Inspection in accordance with these specifications for a representative portion of the epoxy grout installation work.
3. Epoxy grout manufacturer's technical representative performs the following services for at least one rigid equipment mount installation for each equipment type and size installed with epoxy grout:
    a. Inspect ambient conditions during various phases of epoxy grouting installation for conformance with the epoxy grout manufacturer's requirements.
    b. Inspect the surface preparation of concrete substrates onto which epoxy grout materials are to be applied. Inspect surface for conformance to the specified application criteria, including but not limited to substrate profile, degree of cleanliness, and moisture.
    c. Inspect the surface preparation of the metallic substrates onto which the epoxy primer is to be applied.
    d. Inspect the epoxy-primed metallic substrate for coverage and adhesion.
    e. Inspect preparation and application of epoxy grout form work for conformance to the specifications and manufacturer's recommendations for form edge clearance.
    f. Inspect and record that the "pot life" of epoxy grout materials is not exceeded during installation.
    g. Inspect epoxy grout for cure.
    h. Inspect and record that localized repairs made to grout voids conform to the specification requirements.
    i. Conduct a final review of completed epoxy grout installation for conformance to these specifications.
    j. Attest to conformance of the Contractor's work by signing appropriate entries in the "Rigid Equipment Mount Inspection Checklist," Form 43 05 13-A in Section 01 99 90.

B. Training and quality control by the grout manufacturer's technical representative is not required for rigid equipment mounts installed with cementitious non-shrink grout.

3.04 FINAL INSPECTION

A. The Construction Manager will conduct a final inspection with the Contractor for conformance to requirements of this Section.

PART 4 EQUIPMENT MOUNTING SCHEDULE

Equipment Mounting Schedule

Equipment Number	Specification Section	Equipment Pad Detail	Mounting Plate Leveling Tolerance (inch/foot)	Equipment Anchor Type	Equipment Anchor Sleeve Length	Grout Type	Application Notes
Default	Various	D01006	0.005	D01004	10D	Non-Shrink	
Electrical Panels	Various	D01006	Not Applicable	D01004	Not Required	Not Required	
P4051 P4052 P7011 P7012 P7021 P7022 P7031 P7032	43 23 80.12	No Pad	0.02	D01002	Not Required	Epoxy	
P2110 P2120	43 23 89.13	D01007	0.001	D01002	15D	Epoxy	
P2241 P2242 P2251 P2252 P2300 P2421 P2422 P2423	43 23 92	D01007	0.001	D01002	15D	Epoxy	
PV2310 PV2320 PV2330	43 31 13.13	D01006	Not Applicable	D01004	Not Required	Non-Shrink	
Valve Rack	43 31 13.13	D01006	Not Applicable	D01004	Not Required	Non-Shrink	
T2240 T2250	43 41 43.13	D01006	Not Applicable	D01004	Not Required	Non-Shrink	
PV2410	43 31 12	D01006	Not Applicable	D01004	Not Required	Non-Shrink	
PL7020	46 63 76	No Pad	Not Applicable	D01004	Not Required	Non-Shrink	
B2271 B2272	46 61 33	D01007	0.001	D01002	15D	Epoxy	
Valve Racks	46 61 33	D01006	Not Applicable	D01004	Not Required	Non-Shrink	
Membrane Modules	46 61 33	D01006	Not Applicable	D01004	Not Required	Non-Shrink	

END OF SECTION

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SECTION 43 05 14

MACHINE ALIGNMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies requirements for alignment of directly coupled mechanical equipment weighing 1000 pounds or more and/or greater than 30 horsepower furnished or modified under this contract.

B. Equipment direct coupled to the motor with drivers 20 horsepower and less and belt or chain driven machinery are specifically exempted from the requirements of this section.

C. Separately mounted equipment connected by offset universal joints are exempted from the offset and angularity requirements, but all units must be installed and leveled as specified in this section and referenced sections.

1.02 RELATED SECTIONS

A. Section 43 05 11 – General Requirements for Equipment

B. Section 43 05 13 – Rigid Equipment Mounts

C. Section 43 05 17 – Vibration and Critical Speed Limitations

D. Section 43 23 03 – General Requirements for Centrifugal and Axial Flow Pumps

1.03 QUALITY ASSURANCE

A. General:
   1. All equipment shall be aligned using laser alignment equipment to the tolerances specified by the subject equipment manufacturer or the criteria specified in this section, whichever is more stringent.

B. Alignment Criteria:
   1. Unless otherwise specified by more stringent manufacturers' requirements, all mechanical equipment affected by this section shall be aligned to the following criteria:

Maximum Tolerable Misalignment

Speed, rpm, maximum	Short Couplings (distance between flex planes ≤ 4")		Spacer Shafts (angle at each flex plane in mils/inch or projected offset in mils/inch of spacer length)
	Offset (mils)	Angularity (mils/inch)	
600 and less	5.0	1.0	1.8
900	3.0	0.7	1.2
1200	2.5	0.5	0.9
1800	2.0	0.3	0.6
3600	1.0	0.2	0.3
7200	0.5	0.1	0.15

Notes:

1. *Soft foot (machine frame distortion) shall be not more than 2.0 mils for any speed.*
2. *Separately mounted equipment connected by offset universal joints are exempted from the offset and angularity requirements, but all units must be installed and leveled as specified in this section.*

C. Alignment Equipment:

1. Alignment equipment used to perform the work required under this section shall employ laser alignment techniques to achieve the required tolerances. The equipment shall be computer based and its software shall be compatible with current Windows® based spreadsheets and databases. The equipment shall employ a hand-held field computer using a graphic interface to determine actual alignment and necessary corrective action to bring equipment into required tolerance. The link between field measurement components and the computer shall be through cable, infrared, or wireless transmission.

1.04 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
Shaft Alignment Handbook	Shaft Alignment Handbook, Third edition, John Piotrowski, Marcel Dekker Inc.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. Laser alignment equipment shall be Rotalign® Ultra as distributed by Ludeca, Inc., of Doral, Florida, or equal.

2.02 ITEMS TO BE FURNISHED TO OWNER:

A. The following shall be furnished to the Owner upon completion of all alignment work for the project or appropriate portion thereof and prior to substantial completion of the project or portion thereof:
   1. All alignment records, in both hard copy and in computer memory. The hard copy shall be signed and dated by the technician performing the alignment work and shall be witnessed by the Construction Manager.
   2. One complete [Rotalign® Ultra] equipment system, including plastic carrying case, transducer, receiver, equipment mounting brackets, connecting cable, hand-held computer and computer software for use in records computer, or the equivalent complete setup as accepted for the project.

PART 3 EXECUTION

3.01 GENERAL

A. After machine base grouting as specified under Section 43 05 13, all machines mounted on baseplates or soleplates specified above shall be aligned as specified under this section.

B. Alignment work shall be performed by journeyman millwrights skilled in this type of work under the supervision of a technician trained in the use of the laser alignment by the manufacturer or vendor of the alignment equipment. The use of untrained laborers, carpenters or apprentices for this work will not be acceptable.

3.02 PROCEDURE

A. Sequence:
   1. Machines supported on integral feet or support pads shall be leveled, grouted and aligned in the following order: driven machine; intermediate bearings or machines; and driver. Under certain circumstances, such as a diesel engine driving a generator, it may be preferable to reverse this order and set the driver first. The Contractor shall submit a written request for a reversal of the alignment order to the Construction Manager and the Construction Manager must approve any change in alignment order in writing before it will be allowed.

B. Alignment:
   1. All machines shall be rough aligned without any connections to piping, electrical and instrumentation systems. Upon completion of all field connections, alignment shall be rechecked to demonstrate no change. If change has occurred, the Contractor shall eliminate any external forces affecting machine alignment.

2. Next, soft foot (machine frame distortion) shall be measured and brought to within the permissible tolerances (see paragraph 1.02 Alignment Criteria). Thereafter, the alignment shall be rechecked and the alignment process repeated if necessary to bring all machinery to final alignment tolerances.

3.03 VERIFICATION

A. Factory Personnel:
   1. Where required by other sections in this project manual, factory authorized installation technicians representing the equipment manufacturer shall witness final alignment work. After completion of all alignment work, acceptance of the work shall be documented in writing by factory installation technicians.

B. Verification:
   1. All alignment work shall be independently checked using the shaft and coupling spool method described in the Shaft Alignment Handbook. All final results of the alignment work shall be subject to inspection and verification by the Construction Manager.

END OF SECTION

SECTION 43 05 17

VIBRATION AND CRITICAL SPEED LIMITATIONS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies vibration and critical speed limitations for rotating mechanical equipment. Factory and/or field testing and vibration measurements shall be taken when specified in the individual equipment specification sections.

1.02 VIBRATION LIMITATIONS

A. General:
   1. Vibration frequencies shall span the range from 5.0 to 5000 Hz. Where specified, measurements shall be obtained while the installed equipment is operating within the specified speed range.

B. Centrifugal:
   1. Machines With Sleeve Bearings:
      a. Unless otherwise specified, centrifugal machines with sleeve bearing shafts shall not exhibit unfiltered RMS readings for vibration displacement in excess of the following:

Shaft speed range, rpm	Displacement, peak to peak, mils
Up to 900	3.5
901-1800	3.0
1801-3000	2.5
3001-4500	2.0
Above 4500	1.6

      b. Displacement measurements shall be taken radially on the shaft at two points at each bearing, except for well pumps which shall be measured at top of motor. Measuring points shall be 90 degrees apart.
   2. Machines with Antifriction Bearings:
      a. Unless otherwise specified, centrifugal machines with antifriction bearing shafts shall not exhibit unfiltered RMS readings for vibration velocity in excess of 0.12 inch per second. Velocity measurements shall be taken on one point of each bearing housing.

C. Positive Displacement Machines:
   1. Unless otherwise specified, positive displacement machines of the rotary, reciprocating and controlled volume types shall operate without any lateral or torsional vibration characteristics that may accelerate wear of the equipment. The Contractor shall provide manufacturer's certification that the manufacturer has inspected the machine under operating conditions and found it to comply with the requirements of this paragraph.

1.03 CRITICAL SPEED REQUIREMENTS

A. Unless otherwise specified, rotating mechanical equipment shall not exhibit critical speeds within the specified range of operating speeds. Critical speeds for equipment with rigid rotor systems shall be at least 20 percent greater than maximum operating speed. Critical speeds for equipment with flexible shaft-rotor systems shall be at least 15 percent below minimum operating speed and 20 percent above maximum operating speed.

PART 2 PRODUCTS

2.01 PRODUCT DATA

A. Manufacturer's certified data showing location of critical speeds in relation to operating speeds shall be provided as product data in accordance with Section 01 33 00.

PART 3 NOT USED

END OF SECTION

SECTION 43 05 21

COMMON MOTOR REQUIREMENTS FOR EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Squirrel cage type, AC induction motors, up to 500 HP, for up to 4 poles (3600 or 1800 rpm nominal), or up to 250 HP for over 6 poles (1200 rpm or slower) shall be per NEMA MG1, Small or Medium.
   2. Special purpose motors with features or ratings which are not specified herein, are specified in the particular equipment specifications.
   3. High altitude: Refer to paragraph 2.02 A.
   4. Requirements are for the Intake PS and LeChee WTP.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 26 29 23 Variable Frequency Motor Controllers

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ABMA 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	Load Ratings and Fatigue Life for Roller Bearings
IEEE 112	Standard Test Procedures for Polyphase Induction Motors and Generators
IEEE 841	Standard for Petroleum and Chemical Industry- Premium-Efficiency, Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 500 HP
NEMA ICS 2	Industrial Control and Systems Controllers, Contactors and Overload Relays Rated Not More Than 2000 Volts AC or 750 Volts DC
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NEMA MG 1	Motors and Generators
Department of Energy	Energy Policy and Conservation Act, Final Rules EERE-2010-BT-STD-0027-0117
UL 1004	Electric Motors

1.04 DEFINITIONS

A. Terminology used in this Section conforms with NEMA MG-1. Motors covered in this specification are those defined in NEMA MG1 as Small (Fractional horsepower) and Medium (Integral horsepower) AC induction motors.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Unit Responsibility: Where Unit Responsibility is specified in the driven equipment sections of these specifications, the motor supplier shall coordinate with the provider of the driven equipment to verify that the motor provided under this section is fully compatible with and meets the specified performance requirements for that equipment.

1.06 SUBMITTALS

A. Procedures: Section 01 33 00.

B. Provide separate submittals for each of the Intake PS and the LeChee WTP for the following. LeChee PS No. 3 motor submittals are per Section 43 23 92:

C. Action Submittals:
   1. Copy of this Section, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (✓) to denote full compliance with a paragraph as a whole. Underline deviations and denote by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections with justification(s) for any requested deviation will cause rejection of the entire submittal with no further consideration.
   2. Motor Data Sheets specified in this Section and Section 01 99 00.
      a. Motors in conformance with IEEE 841: Manufacturers to complete IEEE Standard 841 Data Sheet for AC Induction Motors.
      b. Motors not in conformance with IEEE 841: Motor supplier to complete Form 43 05 21-A in Section 01 99 90 with required factory data.
      c. Motor Speed-Torque curve, where specified.
   3. Motor mounting, outline, dimensions, and weight.
   4. Motor winding thermostat, where specified.
   5. Motor winding space heaters, where specified.
   6. Motor nameplate data.

D. Informational Submittals:
   1. Submittal requirements for operation and maintenance manuals as per requirements of Section 01 78 23. Provide under the driven equipment specification. Include final reviewed submittal.

1.07 QUALITY ASSURANCE

A. Factory Testing:
   1. All polyphase motors shall be factory tested in conformance with routine tests per NEMA MG1 and IEEE 112. Provide the following tests:
      a. Measurement of winding resistance.
      b. No-load readings of current and speed at normal voltage and frequency.
      c. Current input at rated frequency with rotor at standstill.

d. High potential test.

B. Where specified for use in corrosive locations, motor testing shall additionally be per IEEE 841. Test report shall be certified by the motor manufacturer's test personnel and submitted to the Engineer.
   1. For motors larger than 100 horsepower, test and submit results for the following:
      a. Routine tests per NEMA MG1 and IEEE 112. Provide tests as noted in paragraph 1.07 Factory Testing. Test report shall be certified by the motor manufacturer's test personnel and submitted to the Engineer.
      b. For motors larger than 200 horsepower, efficiency and power factor by Test Method B, IEEE 112. Submit Form B and B-2.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. The manufacturer's standard product may require modification to conform to specified requirements:
   1. Baldor
   2. General Electric
   3. Siemens
   4. US Motors
   5. WEG
   6. Approved Equal

2.02 PERFORMANCE/DESIGN CRITERIA

A. Service Conditions:
   1. Temperature: -25-degree C to +40 degree C.
   2. Altitude: Approximately 4,323 feet above sea level.
   3. Derate motors for higher altitude with motor size based on brake-horsepower.

B. Design Requirements:
   1. Operation: Continuous.
   2. Compliance: Energy Policy Act of 1992 (EPAct), Final Rule 2014.
   3. Tolerance: +/- 10-percent of rated voltage at rated frequency; +/- 5-percent of rated frequency at rated voltage.
   4. Standard design: NEMA Design B.

C. Service Factor (percent of additional horsepower):
   1. 1.15 for Sine-wave motors.
   2. Dual rating: 1.15 Sine-wave and 1.0 Inverter Duty for Inverter Duty motors.

D. Motor Efficiency:

1. NEMA Premium™ efficiency electric motor, single-speed, polyphase, 1-500 horsepower, 3600-rpm 2-pole, 1800-rpm 4-pole, and 1200-rpm 6-pole (1-250 HP), squirrel cage induction motors, NEMA Design B, continuous rated. NEMA Standards Publication MG 1 2011, in Table 12-12.

Table 12-12

Full-Load Efficiencies for 60 HZ Premium Efficiency Electric Motors

Rated 600 Volts or Less (Random Wound)

Enclosed Motors								
HP	2 Pole		4 Pole		6 Pole		8 Pole	
	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1	77.0	74.0	85.5	82.5	82.5	80.0	75.5	72.0
1.5	84.0	81.5	86.5	84.0	87.5	85.5	78.5	75.5
2	85.5	82.5	86.5	84.0	88.5	86.5	84.0	81.5
3	86.5	84.0	89.5	87.5	89.5	87.5	85.5	82.5
5	88.5	86.5	89.5	87.5	89.5	87.5	86.5	84.0
7.5	89.5	87.5	91.7	90.2	91.0	89.5	86.5	84.0
10	90.2	88.5	91.7	90.2	91.0	89.5	89.5	87.5
15	91.0	89.5	92.4	91.0	91.7	90.2	89.5	87.5
20	91.0	89.5	93.0	91.7	91.7	90.2	90.2	88.5
25	91.7	90.2	93.6	92.4	93.0	91.7	90.2	88.5
30	91.7	90.2	93.6	92.4	93.0	91.7	91.7	90.2
40	92.5	91.0	94.2	93.0	94.1	93.0	91.7	90.2
50	93.0	91.7	94.5	93.6	94.1	93.0	92.4	91.0
60	93.6	92.5	95.0	94.1	94.5	93.6	92.4	91.0
75	93.6	92.4	95.4	94.5	94.5	93.6	93.6	92.4
100	94.1	93.0	95.4	94.5	95.0	94.1	93.6	92.4
125	95.0	94.1	95.4	94.5	95.0	94.1	94.1	93.0
150	95.0	94.1	95.8	95.0	95.8	95.0	94.1	93.0
200	95.4	94.5	96.2	95.4	95.8	95.0	94.5	93.6
250	95.8	95.0	96.2	95.4	95.8	95.0	95.0	94.1
300	95.8	95.0	96.2	95.4				
350	95.8	95.0	96.2	95.4				
400	95.8	95.0	96.2	95.4				
450	95.8	95.0	96.2	95.4				
500	95.8	95.0	96.2	95.4				

2.03 MATERIALS

A. Motor frames:

1. TEFC motors shall be cast iron.
2. Aluminum frame motors are not permitted.

B. Stator windings:
   1. Shall be copper with Class F minimum insulation not to exceed Class B temperature rise of 80-degree C at rated load and with Design B torque /current characteristics for all Medium (Integral) motors.
   2. Small (fractional) motors shall be supplied with Class F insulation where available.

C. Rotor material shall be aluminum or copper.

D. Fans shall be non-sparking fan blades.

E. Motor leads shall be non-hygroscopic.

2.04 MOTOR TYPES

A. General Requirements for motors 1/2 horsepower through 500 horsepower:
   1. Three phase, squirrel cage, with copper windings.
   2. Rated for full voltage starting and continuous duty.
   3. Rating shall be:
      a. 460/230 volts, three-phase, 60-Hertz, as shown on the contract drawings.
   4. Not used.
   5. Severe Duty Type Motors, which may also be called Type 2 per the project equipment specifications, shall be in accordance with IEEE 841.
      a. Totally Enclosed Fan-Cooled Motors (TEFC) shall be defined per NEMA MG1.
      b. Enclosure: totally enclosed, fan cooled, with external fan blowing air to the motor frame cooling fins for cooling.
      c. Applications: severe duty and most outdoor installations.
   6. Not used.

B. Motors Less Than 1/2 Horsepower:
   1. Type shall be:
      a. Squirrel cage, capacitor start with Class F insulation and copper windings.
      b. Fan motors rated 1/8 horsepower or less: split-phase or shaded-pole type.
   2. Rating shall be:
      a. 115Volts, single phase, 60 Hz.
      b. 230 Volts, single phase, 60 Hz.

2.05 COMPONENTS

A. Inverter-Fed Polyphase Motors per NEMA MG1 Part 31:
   1. Applications: variable torque or constant torque loads, for vertical or horizontal motors with variable frequency drive controllers (VFD).
   2. Features shall include:
      a. Insulation design to meet 2000-Volt peak at a minimum of 0.1 micro-second rise time.
      b. Built-in motor winding protection as specified.

c. Electrically insulated bearings or,
d. Provide Electro Static Technology's AEGIS Shaft Grounding Ring for Bearing Protection or equal. The shaft grounding ring shall be solidly bonded per manufacturer's recommendations.

B. Vertical Motors:
1. Features: Inverter duty or non-inverter duty with solid shaft P-base and high thrust bearing compatible with loads imposed by the driven equipment.

C. Thermal Protection:
1. Inverter duty motors:
a. Motors up to 50 horsepower:
1) Protection to be NEMA Type 2 bi-metallic thermal switch (Klixon) type.
2) Motor Nameplate: Marked "OVER TEMP PROT 2" in accordance with NEMA MG 1 12.43.
2. Not used.
3. Not used.
4. Not used.

D. Motor Nameplates:
1. Materials: Engraved or stamped stainless steel.
2. Features shall be as follows:
a. NEMA Standard MG 1 motor data.
b. Permanently fastened to the motor frame.
c. ABMA bearing identification number for motors meeting IEEE 841.
d. NEMA nominal efficiency for all motors.
e. NEMA nominal and minimum efficiency for motors meeting IEEE 841.
f. Space heater data.
g. Over Temperature Protection Type Number.
h. Temperature device rating and alarm and shutdown setpoint.

E. Conduit Boxes:
1. Provide oversized boxes, with split construction with threaded hubs and petroleum-resistant gaskets.
2. Conduit boxes can be rotated in order to permit installation in any of four positions 90 degrees apart.
3. Provide grounding lug located within the conduit box for ground connection.
4. Provide separate conduit boxes for temperature devices and space heaters.
5. Separate terminal box for any signal leads (RTD, thermistor, vibration transmitter, etc.).

F. Bearings:
1. Provide oil or grease lubricated ball bearings, angle contact roller bearings for axial thrust loads, and cylindrical bearings for radial-only loads.
2. Rated for a minimum L-10 life of 50,000 hours for direct-connected loads.

3. Cartridge type bearings will not be accepted.
4. Fitted with lubricant fill and drain or relief fittings.
5. Belt loads not to exceed forces calculated from NEMA MG 1 Table 14-1 and 14-1A.

G. Bearing lubrication shall be either grease or oil as per the requirements in either 1 or 2:
1. Grease lubricated bearings:
a. Shall be for electric motor use only.
b. Grease shall be capable of higher temperatures associated with electric motors and shall be compatible with Polyurea-based greases.
c. Provide grease fittings, similar to Alemite™ type (or equivalent).
d. Shielded bearings with regreasable provisions are permissible.
2. Provide oil lubricated bearings with externally visible sight glass to view oil level.

H. Lifting Eyes:
1. Provide lifting eyes with a safety factor of 5.
2. Provide one lifting eye for motors more than 50 pounds.
3. Provide two lifting eyes for motors over 150 pounds.

I. Winding Space Heaters when specified or shown:
1. Provide winding space heaters to prevent condensation.
2. Rating: 120 volts, single phase, 60 Hertz.
3. Motor nameplate to show space heater rating in watts and volts.
4. Provide terminal block in motor conduit box for heater leads termination.

2.06 FINISHES

A. Paint Finish:
1. Provide standard manufacturer paint finish.
2. Provide motors with semi-gloss finish, scratch and heat resistance electric motor paint.

PART 3 EXECUTION

3.01 EXAMINATION

A. Delivery Inspection:
1. Inspect driven equipment-motor assembly and components immediately upon delivery and unloading at the job site for damages.
2. Take photos of damage(s) if any, to substantiate the delivery inspection report.

3.02 INSTALLATION

A. Grounding of Motors:
1. Connect the motor feeder ground cable (green) to the grounding lug terminal in the conduit terminal box.

B. Supplemental Grounding of Motors: Provide for motors powered from VFDs.
   1. Bond the motor frame to the grounding grid/electrode system to provide supplemental grounding.

C. Field Coating of Motors:
   1. Refer to the driven equipment specification section and Section 09 90 00 for coating requirements.

3.03 FIELD QUALITY CONTROL

A. Field Testing:
   1. Measure winding insulation resistance of motors to no less than 10-megohm with a 1000-Vac megohmmeter.
   2. Perform motor phases current imbalance testing for motors 20 horsepower and larger.
   3. Test motors for proper rotation prior to connection to the driven equipment.

B. Field Inspection:
   1. Compare equipment nameplate data with drawings and specifications.
   2. Inspect physical and mechanical condition.
   3. Inspect anchorage, alignment, and grounding.
   4. Verify the installation of breather/drain fittings as specified herein.
   5. Check for proper connections of space heaters, winding and RTDs and or thermostats.
   6. Visually check for correct phase and ground connections:

C. Manufacturer Services: Provide where specified or shown on the drawings.
   1. Provide services to the driven equipment manufacturer for the inspection and certification of the installation of the motor driven equipment.
   2. Provide assistance in the start up and operational testing of the motor driven equipment.

END OF SECTION

SECTION 43 13 13

QUAGGA MUSSEL CHEMICAL FEED EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. General: Provide and install a fully operational chemical storage and feed system for the control of quagga mussels at the intake pump station.

1.02 QUALITY ASSURANCE

A. Unit Responsibility: Assign unit responsibility, as specified in Section 43 05 11, to the pump manufacturer for the pumps, motors, tanks, and injection equipment specified in this Section, Section 46 33 44. Provide a completed and signed Unit Responsibility Certification Form (Form 43 05 11-C, Section 01 99 90).

1.03 SUBMITTALS

A. Procedures: Section 01 33 00.

B. Action Submittals – Shop Drawings and Product Literature:

1. A copy of this specification section, and those listed below with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. Submittal requirements of Section 46 33 44.
3. Completed Certificate of Unit Responsibility attesting that the Contractor has assigned, and that the manufacturer accepts unit responsibility in accordance with the requirements of this Section and Section 43 05 11-1.02. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.
4. A copy of the Intake PS contract document drawings E-106, E-107, and NTUA Technical Provisions PLC Control Panel Sheet 2 of 6 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
5. Marked product literature for equipment provided.

6. Drawings showing general dimensions and confirming the size of pumps, motors, control panels, and specified appurtenances; piping connections; construction details of equipment; wiring diagrams; and weight of equipment.

C. Informational Submittals:
   1. Installation Certification per Section 46 33 44.
   2. Training Certification per Section 46 33 44.

D. Closeout Submittals - Operating and maintenance:
   1. Section 01 78 23.
      a. Include copy of final reviewed submittal.

PART 2 PRODUCTS

2.01 CHEMICAL FEED EQUIPMENT

A. Pump Equipment: The product shall meet the submittal and specifications requirements of Section 46 33 44 except as modified herein.
   1. Provide and install one (1) peristaltic metering pump with floor mounted stand.
   2. Pump shall be compatible with the liquid solution to be pumped as specified below.
   3. Feed rate: 0.0 – 0.5 gph @ 50 PSIG min.
   4. Pump operation shall be automatic. Adjustable speed drives shall be controlled by a 4-20 mA signal.
   5. Power supply: 120V, 60 Hz, 1 phase.
   6. Blue-White Flexflo Model A1V, with tube failure sensor, or approved equal.

B. Solution Tank:
   1. Two 100-gallon minimum translucent polyethylene tank storage systems.
   2. Nalco Mini Plus PORTA-FEED, or approved equal system as supplied by the chemical manufacturer.

C. Molluscicide Solution:
   1. 100 gallons of VeliGON TL-M by Nalco meeting NSF/ANSI Standard 60 for use as a molluscicide solution in drinking water systems.

D. Solution Injection Assembly:
   1. Suitable for raw and potable water.
   2. Chemical injector configuration shall provide a single feed point into the center of the second-stage pump inlet manifold where solution is being injected.
   3. Materials shall be compatible with molluscicide solution and be capable of withstanding the maximum line pressure as determined by the design engineer.
   4. Wetted parts shall be constructed of materials suitable for potable water use.

E. Solution Injection Tube:
   1. An acceptable locking device shall be included to prevent accidental release of the solution tube from the process piping while under pressure.

2. A ball check shall be included to prevent backpressure from the process piping entering the chemical feed system.
3. A stainless safety chain shall be included to prevent withdrawal of solution tube past corporation stop. Safety chain shall be preset by manufacturer for closure of the corporation stop before withdrawal of solution tube.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install pump equipment according to Section 46 33 44, manufacturer's instructions, and local codes where applicable.

B. Peristaltic metering pump to be mounted on a floor stand compatible with manufacturer's installation requirements.

END OF SECTION

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SECTION 43 21 20

PACKAGED BOOSTER PUMP SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope

1. This section specifies the packaged booster pump system for pumping clear potable water for the water treatment plant. The system shall be entirely skid-mounted and shall contain two booster pumps with motor starters and control system and all piping, valves, and appurtenances as specified or as required to make a complete and operable system.

B. Type

1. The packaged booster pump system shall be duplex and utilize an end-suction or vertical multistage centrifugal pump and a variable speed motor starter.

C. Equipment List

Item	Equipment Number
Booster Pump 1	P2710
Booster Pump 2	P2720

D. Operating Conditions

1. The system will be installed in a potable water pumping station, pumping clear potable water. The pumped fluid is expected to range between 40 and 70 degrees F and contain a free chlorine residual of approximately 2.0 ppm. The system will obtain the pumped fluid under pressure from the main potable water pipe prior to exiting the treatment plant. This equipment will provide pressurized potable water at the treatment facility primarily for the bathroom and eye wash stations as well as providing pressurized utility water at utility hydrants stations around the main process area of the facility.
2. The system pump will operate at variable speed to maintain a minimum pressure throughout the system across varying water demands based on use of the facility.
3. The system will be installed in a temperature controlled building containing other mechanical equipment. Ambient temperatures in the room are expected to fluctuate between 65 and 85 degrees F. Ambient humidity will range between 20 and 70 percent.

E. Performance Requirements

Equipment number	P2710, P2720
Condition A [a,d] (Guaranteed Performance):	
Capacity, gpm	38
Total head, feet	104
Net positive suction head available (NPSHA), feet	44
Condition B [b,d] (Minimum Operating Head):	
Capacity, gpm	From H/Q Curve
Total head, feet	81

NPSHA, feet	35
Condition C [c,d] (Maximum Operating Head):	
Capacity, gpm	21
Total head, feet	139
Pump speed	100%

Notes:

a. Condition A shall be taken as the rated operating condition, when the pump is operating at full speed against maximum anticipated system head. It is not intended that the pumps be selected for maximum efficiency at Condition A. Pumps furnished under this section should be selected to achieve Condition A performance, but also operate continuously without objectionable vibration or cavitation at the head specified in Condition B. Condition A may be located in the Allowable Operating Region (AOR) as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application. The AOR is defined as the range of rates of flow recommended by the pump manufacturer over which the service life of a pump is not seriously compromised.

b. Condition B is presented to indicate operating conditions when the pump is operating at full speed against minimum anticipated system head, assuming a hypothetical head-capacity curve. Condition B shall be used for pump selection. Condition B shall be located within the Preferred Operating Region (POR) as established by the pump manufacturer in accordance with ANSI.HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application. Pumps with head-capacity curves steeper than that assumed will produce somewhat less flow at somewhat lower head. The reverse will occur with pumps having shallower head-capacity curves. The POR for most centrifugal pumps is between 70% and 120% of Best Efficiency Point (BEP).

c. Condition C represents the expected momentary (startup/shutdown) condition at full curve that defines the full pump curve. Shutoff head may vary from the value stated above but be a minimum of 10% higher than the head stated in Condition A.

d. Total head in the above tabulation is the algebraic difference between the discharge head and suction head as defined in ANSI/HI 1.1 - 1.6.

F. Design Requirements

Pump	
Efficiency at full speed, percent, minimum (Condition A and Condition B)	45
Piping connection size, inches, minimum	
Inlet	1 1/2
Discharge	1 1/2
Operating speed, rpm, maximum	3780
Motor	
Horsepower, maximum	1
Power	120VAC, 1 phase
Classification	TEFC

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections not specifically listed below may apply.

1. Section 43 05 11: General Requirements for Equipment.
2. Section 43 05 17: Vibration and Critical Speed Limitations.

1.03 QUALITY ASSURANCE

A. References

1. This section contains references to the following documents. These references are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. If requirements of this section conflict with those of the listed documents, requirements of this section prevail.
2. Unless otherwise specified, reference documents refer to documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if no Bids). If referenced documents have been discontinued by the issuing organization, refer to replacement documents issued or otherwise identified by that organization. If there are no replacement documents, refer to the last version of the document before it was discontinued. Where document dates are given in the following listing, those documents refer to the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ANSI/HI 1.1 - 1.6	Centrifugal Pumps
ANSI/HI 9.6.3	Centrifugal and Vertical Pumps - Allowable Operation Region
Hydraulic Institute Standards	Latest Standards of the Hydraulic Institute

B. Unit Responsibility

1. The Contractor shall assign unit responsibility, as specified in paragraph 40 05 71-1.02 C, to the manufacturer of the packaged booster pump system provided under this section. This manufacturer is the unit responsibility manufacturer and has unit responsibility, as specified in paragraph 40 05 71-1.02, for both the equipment assembly specified in this section and all other equipment assembly components specified elsewhere but referenced in this section. A completed, signed, and notarized Certificate of Unit Responsibility (Form 40 05 71 C, Section 01 99 90) shall be provided.

C. Factory Tests

1. The packaged booster pump system shall be completely run tested prior to shipment to verify performance. The complete test of the pumping system shall include operation at the Condition A flow and head and a hydrostatic test at a minimum of 100 psi.

D. Shipment, Protection, and Storage:

1. Equipment shipment, protection, and storage shall conform to the requirements specified in Section 01 60 00.

E. Warranty

1. Provide a one-year, 100 percent parts and labor warranty against manufacturing defects or failure of equipment specified in this Section caused by normal wear and tear. The warranty period shall start from date of final acceptance of the equipment specified in this Section.

1.04 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:

B. Action Submittals – Shop Drawings;

1. A copy of this specification section, and those listed below with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. Completed Certificate of Unit Responsibility attesting that the Contractor has assigned, and that the manufacturer accepts, unit responsibility in accordance with the requirements of this Section and paragraph 40 05 11-1.02 C. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.
3. A copy of the contract document process and instrumentation diagram I-27-101 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
4. Complete descriptive information for the proposed equipment. This shall include performance predictions, materials, weights, connections size and type, detailed electrical and control diagrams, enclosures, and other information necessary to assess conformance to the specifications and the design intent.
5. Foundation mounting requirements and accurate drawing.

C. Informational Submittals:

1. Factory tests, including descriptions of the tests performed and the results of the tests.
2. Installation Certification Section 43 05 11-Form A as specified in paragraph 3.01.
3. Training Certification Section 43 05 11-Form B as specified in paragraph 3.03.

D. Closeout Submittals:

1. Operations and maintenance manuals: Section 01 78 23.
   a. Include final reviewed shop drawing submittal and as-built drawings.
2. Spare parts.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Engineer believes the following candidate manufacturers are capable of producing equipment and/or products which will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturer's standard equipment or products will comply with the requirements of this Section.

B. Candidate manufacturers include:
   1. Grundfos [CMBE TWIN 3-51]
   2. Approved Equal

2.02 MATERIALS

Component	Material
Casing and frame	Cast iron or stainless steel
Impellers	Brass, bronze, cast iron, or stainless steel
Suction and discharge piping	Steel or stainless steel

A. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

2.03 EQUIPMENT

A. Pump:
   1. Pumps shall be end suction or vertical multi-stage centrifugal design. Two duty pumps shall be provided. Pump shall have mechanical seals which do not require the disassembly of the piping to service and replace.

B. Motor:
   1. Motor shall conform to the requirements in paragraph 1.01.

C. Base:
   1. The entire packaged booster pump system shall be mounted on a fabricated steel skid. The control cabinet shall be mounted on a fabricated control cabinet stand attached to the pump system skid.

D. Controls:
   1. GENERAL:
      a. The system controller shall start and stop and control the speed of the pump based on local operation and provide monitoring and protection for the pump and motor.
      b. The pumps shall be configured to operate lead/lag. Alternation is not automatic.

2. CONTROLLER: The controller/adjustable speed drive shall have a NEMA 3R minimum rated enclosure with indicating lights and display.
3. Switches and indicating lights:
    a. Power on/off switch and power on light
    b. Pump status lights, run and alarm/fault
4. Operator Interface Outputs:
    a. Dry contact outputs:
        1) Run status
        2) Fail alarm

E. Valves:
1. Isolation valves shall be installed on the suction and discharge of the pump. Isolation valves shall be rated for a minimum working pressure of 200 PSI.
2. A non-slam check valve shall be installed on the discharge of the pump. The check valve shall be rated for a minimum working pressure of 200 PSI.

F. Auxiliary Devices:
1. The pump suction and discharge piping shall have liquid filled pressure gauges. The range of each pressure gauge shall be as defined in Section 40 06 70:
2. Pump discharge shall have a gage pressure transmitter to detect low and high suction pressures and provide pressure signals to each pump controller. The range shall be 0-200 psi.
3. The pump discharge shall have an expansion tank.
4. Pump A shall start when downstream system pressures drops below 45 psig and shall continue operation until system pressures reach approximately 60 psig. If, after starting Pump A, system pressure continue dropping to values below 40 psig, the system shall start pump B and shall continue operating until downstream pressure exceeds 60 psig.

G. Operation
1. Pump A shall start when downstream system pressures drops below 45 psig and shall continue operation until downstream system pressure exceeds approximately 60 psig.
2. If, after starting Pump A, downstream system pressure drops below 40 psig, the system shall start pump B and shall continue operating until downstream pressure exceeds 60 psig.

H. Motor Starter
1. Motor starter shall be adjustable frequency drive and integral to the motor.

2.04 COATINGS

A. Equipment shall be shop primed and coated with a ANSI NSF-61 certified coating prior to shipment from the factory. Stainless steel piping and components, if applicable, shall be uncoated.

2.05 SPARE PARTS

A. The pump shall be furnished with the following:
   1. One set of all gaskets.
   2. One set of bearings.
   3. One set of bearing rings.
   4. One shaft seal, complete.

B. Spare parts shall be tagged and stored as specified in paragraph 40 05 71-2.12.

PART 3 EXECUTION

3.01 INSTALLATION

A. Each pumping unit shall be aligned, connected, and installed in accordance with the manufacturer's recommendations.

B. The installation shall be certified on Form 43 05 11-A as specified in Section 01 99 90.

3.02 FIELD TESTING

A. The packaged booster pump system shall be field tested in accordance with the requirements of Section 01 45 20 to ensure compliance with the specified requirements.

3.03 TRAINING

A. A minimum of two hours of training conforming to the requirements of Section 01 79 00 shall be provided by the manufacturer. Training shall be certified on Form 43 05 11-B specified in Section 01 99 00.

END OF SECTION

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SECTION 43 23 03

GENERAL REQUIREMENTS FOR CENTRIFUGAL AND AXIAL-FLOW PUMPING EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section, when referenced in the detailed specification section, provides minimum requirements applicable to centrifugal and axial-flow pumping equipment furnished under this contract. More restrictive requirements and/or specific citation or requirement in conflict with a 43 23 03 provision, where found in individual pump specifications, supersede requirements of this section for each specific instance.
2. “Detailed pump specification,” “detailed specification,” “individual pump specification,” “referencing section,” or words of similar import in this section, mean the specification section where the requirements for specific pump performance are presented. “Pumping unit,” whenever and wherever used, means the complete pumping assembly, including driver (whether engine, turbine, or motor) and includes accessories such as variable-speed drives required for motor operation, gear reducers, intermediate shafting and bearings, flywheels, and supports for equipment furnished with the pump.

B. Definitions:

1. The following definitions apply for classifying pumps specified in this and referencing sections:
    a. General: Terminology and definitions in this section follow those established in American National Standards Institute (ANSI)/Hydraulic Institute (HI) 9.1 through 9.5, unless otherwise noted.
    b. Solids-bearing liquids: Liquids to be pumped containing, or assumed to contain, solids that require appropriate pump design considerations and/or materials of construction. Solids-bearing liquids are liquids with settleable solids exceeding 50 milligrams per liter (mg/L) and include wastewater, stormwater, primary effluent, return sludge, return activated sludge (RAS), trickling filter circulation, and similar services.
    c. Clear liquids: Liquids to be pumped mostly free of deleterious solids. Potable water, heat reservoir, raw water, secondary effluent pumping, and similar services are clear liquids.
    d. Efficiency: For the purposes of this section and sections referencing this section, efficiency, as related to pumps, is the ratio of the pump output power (water horsepower [hp]) divided by the pump input power (brake horsepower) required to deliver the total head, with meanings as defined in ANSI/HI 14.2.6.6. For column-type pumps, efficiency is computed inclusive of inlet, bowl, column, and discharge head losses.

e. Net positive suction head, 3 percent reduction (NPSH3): For the purposes of this section and sections referencing this section, NPSH3 means the value of net positive suction head (NPSH) resulting in a reduction of 3 percent in the developed pump discharge head when the pump is tested in accordance with procedures established by ANSI/HI. NPSH3 is the successor designation to net positive suction head required (NPSHR). Where NPSHR is used in the contract documents it means NPSH3.

f. NPSH margin: For the purposes of this section and sections referencing this section, "NPSH margin," wherever used, means net positive suction head available (NPSHA) divided by the candidate pump's NPSH3 for the specific operating condition in question.

g. POR: preferred operating region as defined in ANSI/HI 9.6.3.

h. AOR: allowable operating region as defined in ANSI/HI 9.6.3.

1.02 TYPE

A. Provisions and requirements contained in this section apply specifically to centrifugal and axial-flow pumps, both vertical and horizontal, commonly falling into the generic types covered by ANSI/HI 14.1 through 14.3. This section does not apply, except by specific reference, to positive-displacement pumps of any type.

1.03 REFERENCES

A. This section (Section 43 23 03) contains references to the following documents. They are a part of this section and any referencing section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. The following order of precedence prevails in the event of conflict between the requirements of this section or any referencing section and those of the listed documents (in the order of primacy):

1. The referencing section.
2. This section
3. The referenced document

B. Unless otherwise specified, references to documents mean the documents in effect at the time of advertisement for bids or invitation to bid (or on the effective date of the agreement if there were no bids). References to documents mean the replacement documents issued or otherwise identified by the organization if referenced documents have been discontinued, or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ABMA 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	Load Ratings and Fatigue Life for Roller Bearings
AISC	American Institute of Steel Construction—Manual of Practice
ANSI/API 610	Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries (also referenced as ISO 13709-2009)
ANSI/ASME B46.1	Surface Texture, Surface Roughness, Waviness and Lay

Reference	Title
ANSI/HI 9.1–9.5	Pumps – General Guidelines for Types, Applications, Definitions, Sound Measurements and Documentation
ANSI/HI 9.6.1	Rotodynamic Pumps—Guideline for NPSH Margin
ANSI/HI 9.6.2	Centrifugal and Vertical Pumps for Allowable Nozzle Loads
ANSI/HI 9.6.3	Rotodynamic Pumps (Centrifugal and Vertical) Guideline for Allowable Operating Region
ANSI/HI 9.6.4	Rotodynamic Pumps—Vibration Measurements and Allowable Values
ANSI/HI 9.6.6	Rotodynamic Pumps for Pump Piping
ANSI/HI 9.6.8	Rotodynamic Pumps—Guideline for Dynamics of Pumping Machinery
ANSI/HI 9.8	Pump Intake Design
ANSI/HI 11.6	Submersible Pump Tests
ANSI/HI 14.1-14.2	Rotodynamic Pumps for Nomenclature and Definitions
ANSI/HI 14.3	Rotodynamic Pumps for Design and Application
ANSI/HI 14.4	Rotodynamic Pumps for Installation, Operation, and Maintenance
ANSI/HI 14.6	Rotodynamic Pumps for Hydraulic Performance Acceptance Tests
API 686/PIP REIE 686	Recommended Practices for Machinery Installation and Installation Design
ASME B18.8.2	Taper Pins, Dowel Pins, Straight Pins, Grooved Pins, and Spring Pins (Inch Series)
ASME Code	ASME Boiler and Pressure Vessel Code
ASTM A27	Steel Castings, Carbon, for General Application
ASTM A36	Carbon Structural Steel
ASTM A148	Steel Castings, High Strength, for Structural Purposes
ASTM A322	Steel Bars, Alloy, Standard Grades
ASTM A564	Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A571	Austenitic Ductile Iron Castings for Pressure-Containing Parts Suitable for Low-Temperature Service
ASTM A995	Standard Specification for Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts, Grades 2A, 3A, or 6A
ASTM B148	Aluminum-Bronze Sand Castings
AWWA C213	Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
AWWA C550	Protective Epoxy Coatings for Valves and Hydrants
NSF/ANSI 61	Drinking Water System Components – Health Effects
IEC 61298-2	Process Measurement and Control Devices. General Methods and Procedures for Evaluating Performance Tests Under Reference Conditions
ISO 1940-1:2003	Mechanical Vibration—Balance quality requirements for rotors in a constant (rigid) state—Part 1: Specification and verification of balance tolerances
ISO 9001	Quality Management Systems—Requirements, 3rd Edition (2000)
ISO 10816-1	Mechanical Vibration—Evaluation of Machine Vibration by Measurement on Non-rotating Parts—Part 1: General Guidelines, Annex B, Table B.1. Class I, II or II, as applicable. For the purposes of this specification, Annex B of ISO 10816, Part 1 forms a part of this specification and ISO 10816, Part 1.
ISO 10816-3	Mechanical Vibration—Evaluation of Machine Vibration by Measurement on Non-rotating Parts—Part 3: Industrial machines with nominal power above 15 kW and nominal speeds between 120 r/min and 15000 r/min when measured in situ, Annex A, Table A.1 and A.2. For the purposes of this specification, Annex A of ISO 10816, Part 3 forms a part of this specification and ISO 10816, Part 3.
ISO 10816-6	Mechanical Vibration—Evaluation of Machine Vibration by Measurement on Non-rotating Parts—Part 6: Reciprocating machines with power ratings above 100 kW, Annex A, Table A.1, machine vibration classification number 3. For the purposes of this specification, Annex A of ISO 10816, Part 6 forms a part of this specification and ISO 10816, Part 6.

Reference	Title
ISO 10816-7	Mechanical Vibration—Evaluation of Machine Vibration by Measurement on Non-rotating Parts—Part 7: Rotordynamic Pumps for Industrial Applications, Including Measurements on Rotating Shafts, Annex A, Tables A-1 and A-2 Category II as applicable. For the purposes of this specification, Annex A of ISO 10816, Part 7 forms a part of this specification and ISO 10816, Part 7.

1.04 DESIGN REQUIREMENTS, ALL PUMPS:

A. General:

1. Equipment furnished under sections referencing this section shall meet the longevity objective that the pumping equipment, motor, shafting, couplings and appurtenances are designed for at least a 20-year service life and 3 years of "uninterrupted operation." Select all components associated with the rotating elements in the drive train, including equipment supports and supports for rotating elements, that are designed to function without damage or disassembly at reverse rotational speeds up to 130 percent of maximum operational speed during flow reversals through the pump. The complete pumping unit shall operate without overload on any component at any point along the pump's entire full-speed operating curve. Furnish pumps required by virtue of the specified operating conditions to operate against a closed valve or throttled for any period of time exceeding 5 seconds with drivers sized to operate continuously at the power requirement for that condition even though the power requirements at the rated condition may be less.
2. Pump selections proposing maximum diameter impellers for the proposed pump model and casing size will not be accepted.
3. With the exception of submersible pumps and the inlet connection for pumps designed to operate in open forebays or wetwells, pump connection nozzles shall be designed for the loads and moments stipulated in ANSI/HI 9.6.2. Where ANSI/HI 9.6.2 does not cover a specific pump type or category, or where that document is silent on allowable nozzle loads or a particular type of nozzle load (e.g., thermal pipe strain), the contractor shall furnish documentation from the manufacturer attesting to the limitations on loads and moment forces that can be tolerated on each connection and recommended connection details to be used.

B. Pump Selection:

1. Proven designs:
   a. Pumps furnished under sections referencing this section shall be proven designs that have been in similar conditions of service with no objectionable performance characteristics for a period of not less than 5 years. The contractor shall furnish a detailed list of installations with contact information supporting qualification under this requirement with the information required under paragraph 1.06. To satisfy this requirement, the listed pump shall be of the same size volute or bowl, discharge case and nozzle size, and impeller design (including number of vanes) and is operating under similar conditions of pumped fluid, head, capacity, speed, rotation, and NPSHA.
   b. The contractor may propose alternative equipment that cannot meet the requirement for a proven design under this paragraph, subject to additional documentation requirements and under the following conditions:

1) The proposed design has been in successful operation under similar conditions of volute or bowl, discharge case and nozzle size, impeller design (including number of vanes), pumped fluid, head, capacity, rotation, and NPSHA, but at a higher speed for a period of not less than 3 years.

2) The proposed design has been in operation in designs where both larger and smaller nozzle size pumps have been in service for a period of not less than 5 years, and impeller design (including number of vanes, plus or minus one vane in pumps with four or more vanes), pumped fluid, head, capacity, speed, and NPSHA are similar to that for the proposed installation and within one synchronous speed higher or lower than that indicated in the detailed specification.

3) In addition to the installation list required under this paragraph, provide dimensional drawings, bill of materials, and historical (certified) shop test results for candidate pumps documenting performance including, but not limited to head, capacity, speed, and NPSHR, and limit of stable hydraulic operation based on the onset of suction recirculation, if available. Results should match or bracket the specified performance and two or more candidate pump results may be required.

c. If the proposed pump is not a proven design under either of the above paragraphs, the contractor shall demonstrate, by operation of a test pump in a fully equipped hydraulic test facility, that the proposed pump in the size and at the speed proposed with the proposed impeller design will have acceptable operating characteristics under the conditions specified for the proposed installation. Set up the test pump and perform a witnessed demonstration prior to designing, fabrication, and testing of any of the equipment proposed for the specific installation.

2. General performance criteria:

a. Pumps furnished under this section and any referencing section shall operate without loss of head due to cavitation or vibration over the entire specified range of flow and head conditions and are specifically selected for NPSH margin requirements detailed in paragraph 1.04 NPSH margin limitations. Pump selections that do not provide the specified margin will be rejected.

3. General design criteria:

a. Select pumps furnished under sections referencing this section that are designed in accordance with applicable portions of ANSI/HI 9.6.2, 9.6.3, 9.6.4, 9.6.6, 9.6.8 and 14.1-14.3 and the requirements of this section. Select pumps that are specifically designed to pump the fluid described in the detailed specification and to operate without clogging or fouling caused by material in the pumped fluid at any operating condition within the range of service specified. Clogging or fouling conditions may be of any cause, demonstrated by a 5 percent or greater capacity drift within 2 hours of sustained operation.

b. Unless otherwise noted or specified, slope pump head capacity curves in one continuous curve within the specified operating conditions. Do not permit points of reverse slope inflection capable of causing unstable operation within the specified zone of continuous-duty operation. Pumps with head/capacity curves with a reverse inflection are specifically prohibited if these characteristics will cause unstable operation within the specified range of operating conditions and where startup/shutdown conditions entail operation against a slow opening/closing valve.

c. Column-type (vertical-turbine, vertical-column solids-handling, and axial-flow propeller and mixed-flow) pumps shall have bells selected to provide intake velocity of not less than 3.5 feet per second (ft/s) or more than 4.0 ft/s when operating at the maximum specified flow or the flow resulting from the lowest specified operating head at maximum speed, whichever is greatest ("peak flow"). Pump discharge column sizes shall limit the calculated average velocity at peak flow to no more than 12 ft/s.

d. Pumps specified to operate at constant-speed shall function without loss of head or capacity due to cavitation or excessive vibration over the entire specified range of flow and head conditions defined by the region bounded by Condition Points A, B, and C and any other continuous-duty operating condition specified in the detailed specification referencing this section. In addition, constant-speed pumps shall be selected to place Condition Point C in the detailed specification within the POR, or a modified POR if stipulated in the detailed pump specification.

e. Pumps specified to operate at variable-speed shall function without loss of head or capacity due to cavitation or excessive vibration over the entire specified range of flow and head conditions defined by the region bounded by Condition Points A, B, and C and any other continuous-duty operating condition specified in the detailed specification referencing this section. Unless otherwise specified in the section referencing this section, acceptance criteria shall include the following:

   1) Operating Condition Point C and any other continuous-duty operating point specifically required in the detailed specification shall reside within the region defined by the POR, or in a modified POR if stipulated in the detailed pump specification.

   2) Unless otherwise noted in the detailed specification referencing this section, Operating Condition Point A may reside in the AOR outside the POR; Condition Point C will be located within the POR, or in a modified POR if stipulated in the detailed pump specification; and Condition B will preferably be located within the POR, or within 5 BEPQ percentage points (in terms of flow) outside the POR so long as Condition Point C resides in the POR or the stipulated modified range.

4. POR:

   a. Unless otherwise specified, the POR for a given pump is as defined in ANSI/HI 9.6.3.

   b. The detailed specifications may stipulate a narrower POR than indicated in ANSI/HI 9.6.3.

   c. The suction-specific speed (S) shall not exceed 8,500, unless otherwise indicated in the detailed specifications.

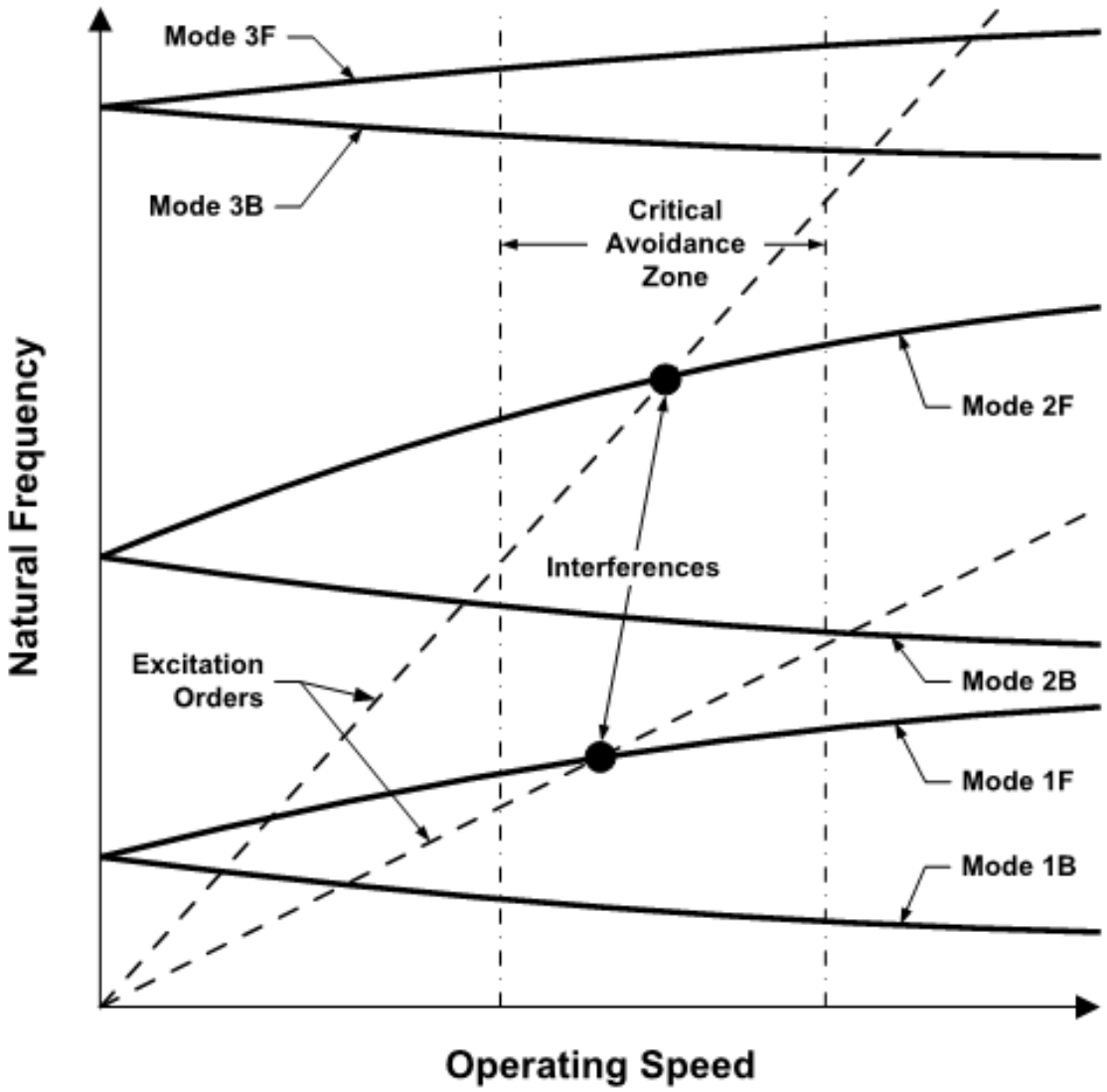
   d. For high- S pumps (greater than 8,500) and other conditions as determined by the engineer, a narrower stable operating region may be defined in the detailed specifications and then identified in ANSI/HI 9.6.3 for the POR. The detailed specifications take precedence over this section.

   e. The detailed specification sections identify the duty points that must be within a pump's POR and those that may be within the AOR and take precedence over this section.

C. Critical Speeds and Natural Frequencies:
   1. General:
      a. The criteria of this paragraph applies to pumps, provided that the foundation and support details provided at the time of pump design are accurate. Repair or replace pumps exhibiting adverse behavior after installation from resonance, vibration, or fatigue at no cost to the owner. The criteria apply to the equipment in "like-new" condition as well as the "as-worn" condition (i.e., when parts, individually and as a composite, reach the manufacturers' maximum tolerances). Critical speed and natural frequency data submittal requirements depend upon the pump:
         1) For pumps covered under paragraph 1.04 Alternate mass elastic design, where specified in the detailed specification section, the contractor is required to submit analytical reports confirming requirements on critical speeds and natural frequencies prior to pump fabrication, as specified
         2) Unless otherwise specified, for constant-speed pumps and variable-speed pumps with suction size less than 6 inches diameter, no critical speed submittal is required.
   2. Alternate mass elastic design:
      a. Subject the complete pumping unit (including rotating elements, frames, and supports) and related structural elements (including pump, motor, and bearing supports) to structural, lateral, and torsional dynamic analyses, per ANSI/HI 9.6.8 Level 2 and as follows:
         1) Select the complete pumping unit rotating group including pump, motor, intermediate shafting and flywheel rotors (if specified), and other elements in the power train (or powered via the power train) that are designed and manufactured to limit torsional stresses.
         2) Additionally, for vertically suspended (VS) and vertically mounted overhung (OH) and between bearing (BB) types provide pump structural natural frequency analysis by modal finite element analysis (FEA)
         3) Motors for vertical pumps, subjected to Level 2 analyses shall be subjected to bump test requirements under paragraph 1.04 Motors for custom-engineered pumps.
      b. Professional qualifications:
         1) The contractor shall require the manufacturer of the pumping equipment to provide the required analyses either with a qualified design professional employed by the manufacturer or a person employed by an independent firm that may have other contract relationships with the pump manufacturer.
         2) Aside from allowing the qualified design professional to be employed by the manufacturer or an independent firm that may be contracted to manufacturer, all other qualifications requirements of paragraph 1.05B.2 Professional qualifications apply. Provide a letter, signed by an officer of the manufacturer, describing the role of design professional and relationship to the manufacturer, in lieu of notarized certification.
      c. Reports, calculations and recommendations:
         1) All documentation shall be provided as specified in paragraph 1.05.
         2) A field torsional vibration test is required.

d. Methodology:
    1) Conduct analyses in accordance with paragraph 1.05 Lateral rotor and structural dynamic analyses, except as noted:
        a) Analyses based on a Level 2 analysis prescribed in ANSI/HI 9.6.8:
        b) Mathematical calculation tools in compliance with ANSI/HI 9.6.8, as selected by the design professional.
    2) In case of conflict between these specifications and ANSI/HI 9.6.8, these specifications shall prevail (e.g., Campbell diagrams shall be provided), unless an exception is requested by the Contractor and approved by the Construction Manager.

3. Lateral rotor and structural dynamics:
    a. The complete pumping unit, composed of the entire rotating group and related frames, supports, enclosures, housings, and casings, shall be free from critical speeds from 15 percent below to 25 percent above the operating speeds required to achieve the specified performance characteristics (critical avoidance zone). A critical speed is defined as any damped natural frequency with a logarithmic decrement less than +0.3 that has an interference with a primary excitation order in the critical avoidance zone. Analyze backward rotation for rubber-bearing vertical-column pumps. The critical avoidance zone, interferences, and possible critical speeds can be illustrated on a natural frequency map as presented in the figure below. In the figure, three natural frequencies are shown with forward and backward modes. Only two of those modes, 1F and 2F, have interferences with primary excitation orders. Whether these are critical speeds is determined by the value of log decrement at the intersection. Note that higher order modes, such as 2F, have the same log decrement criterion as the first mode.



b. Process sensitivities are such that operation at infinitely variable speed within the specified operational conditions is an absolute requirement. Any remedy imposing a locked-out speed interval or intervals will not be considered an acceptable remedy for identified critical speeds. Acceptable remedies include combinations of adjustments in rotor geometry or materials, and the substitution of energy-absorbing couplings. Other remedies may be considered so long as they are justified in writing and the proposal is sealed and signed by the design professional retained by the manufacturer to perform the system mass elastic system analyses.

4. Torsional rotordynamics and combined shaft stress:
   a. The complete rotating group shall be free from critical speeds from 10 percent below to 20 percent above the operating speeds required to achieve the specified performance characteristics (critical avoidance zone). A critical speed is defined as any damped natural frequency with a logarithmic decrement less than plus 0.3 that has an interference with a primary excitation order in the critical avoidance zone.

b. If efforts to remove torsional critical speeds are unsuccessful, perform a combined shaft stress analysis to demonstrate that the response does not adversely affect the entire rotating group fatigue life. The combined shaft stress analysis shall consider any speed in the critical avoidance zone and during startup, shutdown, or motor control transients if synchronous motors are specified.

c. For constant-torque applications, the pump-rotating group shall be free from torsional response that produces combined (steady plus alternating torque induced) stresses exceeding 50 percent of the material's fatigue limit or 30 percent of the material's elastic limit (but no more than 18 percent of the material's ultimate tensile strength) if relevant fatigue data for the selected material are not available.

d. For variable-torque applications (including variable-speed pumps, vertical pumps, and pumps with large overhung loads) the pump rotating group shall be free from torsional response that produces combined (torsional steady and alternating) peak shear stresses at points of stress concentration (calculated in accordance with the requirements of paragraph 1.04E.3 Torsional Shaft Stresses) that exceed 50 percent of the material's fatigue limit or 4 percent of the material's ultimate tensile strength, based upon ASME or other recognized standard, if relevant fatigue data for the selected material are not available.

e. Document the source of fatigue data used in lieu of elastic or ultimate strength ratios in the analysis report submittal.

D. Impeller clearances, vane-passing frequency, and impeller keyways:

1. The radial clearance between the tip of the impeller vane and diffuser or volute vanes shall be not less than 3 percent and 6 percent, respectively, of impeller diameter. Select a pump that is designed so that internal geometry does not cause uneven flow distribution at impeller vane inlets.

2. Impeller vane combinations shall not be an even multiple of diffuser vanes in column-type pumps.

3. Cut impeller keyways for multistage column-type pumps at differing positions and provide equal angular spacing on the impeller shaft to avoid multiple simultaneous vane-passing pulses.

E. Component design criteria:

1. General:

a. Unless otherwise specified, ensure that combined stresses in steel frames and supports does not exceed those permitted by the American Institute of Steel Construction (AISC) Manual of Practice. Combined stresses in cast, forged, rolled, or fabricated pressure-retaining components, frames, and supports shall not exceed that allowed for the given material in Section VIII, Division 1 of the American Society of Mechanical Engineers (ASME) Code. Design pressures for pressure-retaining parts shall be not less than 50 percent greater than the pump's shutoff head at the manufacturer's listed maximum operating speed. The pump casing strain at any head on the full-speed operating curve (including allowances for increases caused by specified multistage applications) shall not result in distortions at the bearing housings greater than the maximum allowable by the bearing manufacturer to provide the specified bearing life.

b. The term “combined stresses” in this section means the sum of operating stresses, including stresses induced by dynamic and static forces as developed via the analysis procedures stipulated in this section. Static forces (x, y, z, and moments in planes) include the relevant maximum nozzle loads specified in ANSI/HI 9.6.2 or as stipulated by the pump manufacturer. Dynamic forces include both steady-state and transient stresses induced by operating conditions within the zone of operation established by the specified operating conditions.

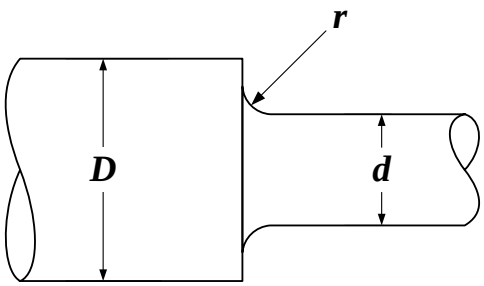
2. Anchorage and equipment mounts:
   a. The contractor shall hold the pump manufacturer responsible for the design of the anchor-bolting system and equipment supports for each separately mounted component furnished under the detailed specification. Conform anchorage and equipment support requirements for pumps to the requirements of Section 43 05 13.
   b. Select anchor bolts and connecting bolts for pumps and assemblies supported by other assemblies furnished under this section, or sections referencing this section, that are designed in accordance with Section 01 73 24. All operation and maintenance (O&M) manuals for pumps and assemblies shall contain criteria for anchor and baseplate bolt torque values.
   c. Equipment mounts for vertical (column- and volute-type) pumps weighing more than 1,000 pounds, with discharge nozzles 6 inches in diameter and greater, shall employ soleplates conforming to the requirements of Section 43 05 13. Provide soleplate mounting conforming to Section 43 05 13 for separately supported components in the pump drive system. Fabricated steel supports regardless of design, and the nature of the structural shapes used for such proposed supports, will not be accepted.
   d. Soleplates shall be designed to span openings for equipment connections and provide access to maintenance points. Soleplates shall be of sufficient section to key, not less than 1 inch, into the supporting grout provided for bonding the soleplate to the structure. Provide soleplates of sufficient size to bolt the pump base to the soleplate [and allow doweling the pump base to the soleplate] without encumbering the anchor bolts required for clamping the soleplate to the structure.
   e. Equipment mounts for horizontal pumps shall be designed in accordance with Section 43 05 13 and ANSI/HI 14.3, and shall provide common support for the pump and motor (and flywheel, if one is specified). Conform baseplate bolting to assumptions contained in ANSI/HI 9.6.2. [Drill and dowel pin the pump base to the baseplate in addition to bolting.]
   f. Use tapered dowel pins when required in the detailed specification to record the final position of machine bases on soleplates or pump baseplates. Where specified, harden and machine-ground dowel pins, conforming to the requirements of ANSI/ASME B18.8.2. Conform holes for tapered dowels to the requirements set forth in Appendix A of ANSI/HI B18.8.2.
3. Torsional shaft stresses:
   a. Calculate shaft stresses using the following equation and the stress concentration factors in the tables below:

$$S = S_{cf} \times \frac{G \times D \times \Delta_{\Theta}}{2 \times L}$$

where:

S	=	stress, pounds per square inch (psi)
S_{cf}	=	stress concentration factor, dimensionless
D	=	minimum shaft diameter at point of concentration, inches
Δ_{Θ}	=	twist in shaft between adjacent masses, radians
L	=	effective length between masses, inches
G	=	shear modulus of shaft material, psi

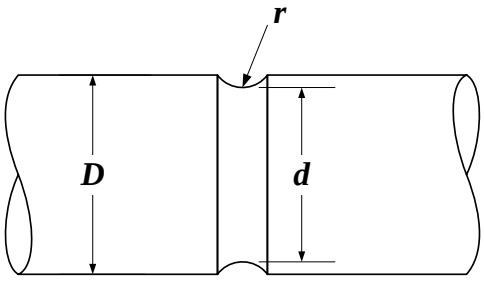
b. S_{cf} shall be applied at changes in shaft diameter is as follows:



Shaft diameter ratio D/d = 1.05	
r/d	S_{cf} [a]
0.0025	2.67
0.0100	1.84
0.0200	1.58
0.0300	1.47
0.0400	1.39
0.0500	1.34
0.1000 and greater	1.22

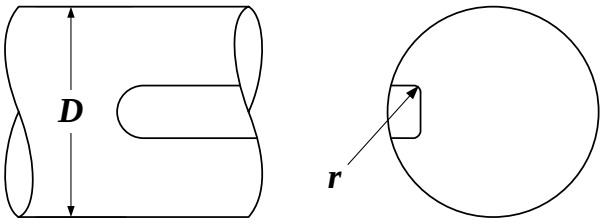
Shaft diameter ratio D/d = 1.50	
r/d	S_{cf} [a]
0.0025	4.05
0.0100	2.54
0.0200	2.07
0.0300	1.85
0.0400	1.72
0.0500	1.62
0.1000 and greater	1.40

c. Ensure that the S_{cf} to be applied at circumferential shaft grooves is as follows:



Shaft diameter ratio D/d = 1.05		Shaft diameter ratio D/d = 1.30	
r/d	S_{cf} [a]	r/d	S_{cf} [a]
0.0025	3.73	0.0025	5.04
0.0100	2.34	0.0100	2.82
0.0200	1.92	0.0200	2.24
0.0300	1.74	0.0300	1.99
0.0400	1.64	0.0400	1.84
0.0500	1.57	0.0500	1.73
0.1000 and greater	1.39	0.1000 and greater	1.49

d. Ensure that the S_{cf} to be applied at the roots of keyways is as follows:



r/D	S_{cf} *
0.0025	4.35
0.0100	3.20
0.0200	2.64
0.0300	2.43
0.0400	2.32
0.05 00	2.25
0.1000 and greater	2.12

** Base values of S_{cf} between data points in the tables above upon a straight-line interpolation.*

4. Shaft deflection:
   a. Select pump shafts installed on volute-type pumps to provide sufficient stiffness to operate without distortion or damaging vibration throughout the range of service specified. Limit shaft deflection at the face (impeller side) of the shaft seal to no more than 2 mils at any operating condition within the zone described by the specified continuous-duty operating conditions. Calculate deflection at the shaft seal as required by provisions set forth in ANSI/HI 14.3.
5. Bearings:
   a. Unless otherwise specified, select anti-friction bearings for pumps for a minimum L–10 life of 50,000 hours in accordance with ABMA 9 or 11. Ensure that anti-friction bearings for custom-engineered pumps have bearings selected for an L–10 life of 100,000 hours in accordance with ABMA 9 or 11. Select bearings for other elements in the rotating system such as motors, intermediate shaft bearings, and flywheel bearings using the same criteria as specified for the pump. Base bearing selection upon the worst combination of continuous-duty operating conditions specified and include both steady-state and transient loads. Provide calculations supporting the selection of bearing sizes as and informational submittal.

6. Bearing isolators:
    a. Unless otherwise specified, fit pump and motor bearings with bearing isolators, specifically selected for the size and type of bearing. Provide bearing isolators that are the labyrinth, non-fretting type designed to expel contaminants by centrifugal force and prevent the escape of lubricants. Provide vapor-block capability. Bearing seals shall be Inpro/Seal, or an approved equal.
7. Pump shaft seals:
    a. Unless otherwise specified in the detailed specification, pump shaft seals must be mechanical seals as specified in Section 43 05 11.

F. NPSH margin limitations:
1. General:
    a. Pumps furnished under this section and sections referencing this section shall be selected for NPSH margin limitations using the criteria set forth in this section. Base NPSH3 characteristics for the candidate pump upon documented test data not more than 5 years old. Perform testing on a pump not more than two nominal pump diameters larger or smaller than the proposed pump with an impeller of the same geometry as that proposed for the pump to be used for the subject application, and operating at either the same speed as the pump for the proposed application or a speed that provides plus or minus 10 percent of the impeller inlet velocity if reduced-speed testing is used. For very large pumps that cannot be accommodated in the manufacturer's test pit, the use of a model pump, sized in accordance with ANSI/HI 14.6, Appendix K, is acceptable. The contractor shall document the basis for pump selection based upon NPSH margin limitations as set forth in this paragraph.
    b. The detailed specification sections provide NPSHA information for anticipated operating conditions for each application. This information is generally referenced to a specific elevation, stated in terms of project datum. The contractor is responsible for requiring the pump manufacturer to adjust the NPSHA information in the specification section to the elevation of the pump impeller eye for the specific pump model and size proposed for the application. NPSH3, as used in the following paragraphs, means the NPSH3 at the impeller eye, determined in accordance with ANSI/HI 11.6 or 14.6, as applicable for the proposed pump. The contractor shall require the pump manufacturer to document the method used to determine NPSH3 for the proposed pump and justifying compliance with the NPSH margin limitations established under this paragraph for each specified operating condition in material submitted under paragraph 1.06. Include in the documentation justification of the NPSH3 tests used to develop NPSH3 characteristics, including the following:
        1) Date, test procedure, and test logs of original NPSH3 information used to project requirements for the pump selected for the application.
        2) Test pump size, impeller diameter, impeller model, eye diameter, and speed
        3) Calculations projecting NPSH3 test information to NPSH3 curve information for the pump proposed for the application.
        4) Calculations demonstrating compliance with the NPSH margin requirements established in this paragraph.

c. The contractor shall submit the manufacturer's margin calculations justifying the proposed pump selection with the material required under paragraph 1.06. The NPSH margin ratios specified in this paragraph are the minimum acceptable margin ratios. If the proposed pump requires greater margin ratios to operate within the specified operating conditions without loss of head due to cavitation, then it is the responsibility of the contractor to bear costs associated with achieving the required margin ratio by lowering the elevation of the pump setting, lowering the elevation of the structure, or through other means. Subject any such adjustments to review and acceptance by the construction manager if necessary.

d. Individual restrictions are applicable to NPSH margin depending upon the type of pumping equipment and the fluid to be pumped as set forth in ANSI/HI 9.6.1, Table 9.6.1.5.5. Under no circumstances may the absolute value of the NPSH3 margin be less than 3.5 feet.

G. Electric Motors:

1. General:

a. Pumps shall be electric-motor driven unless otherwise specified. Select all motors to be non-overloading at any operating point along the pump's full-speed operating curve, including points located beyond specified operating conditions. Motors shall be capable of carrying the axial/radial load applied to the motor shaft with motor bearing life equivalent to the pump bearing life.

b. All vertical motors shall be solid-shaft construction. Hollow-shaft motors will not be accepted.

c. Motors furnished with pumps specified for operation at variable-speed shall be inverter-duty types conforming to the requirements of Section 43 05 21 and shall be compatible with the variable-speed equipment furnished with the pump.

d. Protect motor bearings with bearing isolators as specified in paragraph 1.04.C.6.

1.05 QUALITY ASSURANCE: ALL PUMPS

A. Quality Certification:

1. All manufacturers and manufacturing sites proposed by the contractor for supply of equipment furnished under this section and sections referencing this section shall hold current certification under ISO 9001. Application for certification under ISO 9001 is not deemed as an acceptable substitute for current certification. Provide documentation of the manufacturer's ISO 9001 certification and the manufacturer's written quality assurance/quality control (QA/QC) program.

B. Unit Responsibility:

1. The contractor shall assign unit responsibility to the pump manufacturer in conformance with the requirements of Section 43 05 11.

C. Performance Confirmation:

1. Hydrostatic tests:

a. Subject all pressure-sustaining parts to factory hydrostatic tests. Unless otherwise specified, conform hydrostatic tests to the requirements of ANSI/HI 11.6 for submersible pumps and ANSI/HI 14.6 for dry pit pumps. Unless otherwise indicated in the detailed specifications, hold castings at the test pressure for the duration indicated in ANSI/HI 11.6 and 14.6. For process pumps designed in accordance with ANSI/API 610, hydrostatic testing must comply with the requirements of paragraph 8.3.2 of ANSI/ ANSI/API 610. Test results shall be certified correct by the chief engineer or individual in responsible charge of the manufacturing facility.

2. Performance guarantee:
   a. Unless specified otherwise in the detailed specification, pump performance (flow and head, efficiency, and NPSH3) shall be guaranteed by the pump manufacturer to the criteria specified under this paragraph.
   b. Equipment performance documentation, including test data, where tests are specified, shall include sufficient test points (not less than eight) to document hydraulic performance along the complete head/capacity curve from shutoff to maximum capacity, and covers full-speed operating points specified in the detailed specification section referencing this section. Tests conducted at specified operating conditions shall be with the inlet throttled to produce the NPSHA indicated for that specific condition in the detailed specification. Perform NPSH3 tests for not less than four full-speed operating conditions, but not less than specified operating conditions and at the best efficiency point (BEPQ).
   c. Test procedures shall be as set forth in ANSI/HI 14.6, and as specifically detailed in these specifications. However, any increase in flow or head permitted under specified acceptance grade[s] cannot result in overload (nameplate basis, S. F. = 1.0) of the specified motor power rating at any location on the pump's head/capacity curve. Conduct performance tests at the specified maximum speed. Affinity relationship-predicted test results will not be accepted. For column-type pumps, include in the performance documentation curves showing both bowl efficiency and overall efficiency (including inlet, bowl, column, and discharge head losses) at maximum operating speed for the application.
   d. The acceptance criteria for head and capacity test results shall be based upon the rated condition specified in the detailed specification and as required in ANSI/HI 11.6 and 14.6 for acceptance Grade 1U, with the above-stated limitation with respect to motor power overload.
   e. Where there are none stipulated, the acceptance criteria for head and capacity test results for the other specified duty conditions in the detailed specification shall be as required in ANSI/HI 11.6 and 14.6 for acceptance grade 3B, with the above-stated limitation with respect to motor power overload.
   f. The acceptance criteria for NPSH3 at any specified operating condition shall be the values proposed by the contractor in the curves submitted under paragraph 1.06, and duly accepted by the construction manager, with a tolerance of plus 0, minus unlimited, with the exception that S, as calculated for the specific pump, does not exceed the limitation established under paragraph 1.04B. If the NPSH3 data result in an increase in S, the manufacturer shall confirm that the stable operating region for the pump corresponds to the POR as defined in ANSI/HI 9.6.3, and that the operating conditions specified to be within the POR are within the stable operating region for the pump. In addition, the manufacturer shall identify the onset of suction recirculation and confirm that the onset of suction recirculation is outside of the specified operating range.

g. Include in the guarantee a statement to the effect that the pump will operate within the operating regions specified in the detailed specification. The guarantee shall be in writing and signed by the chief engineer or individual in responsible charge of the test facility. Under no circumstances should deviations from specified operating conditions result in overload of the driver furnished with the equipment, nor should such deviations result in power requirements greater than the driver's nameplate (1.0 service factor) rating.

3. Non-witnessed tests:
   a. Unless specified otherwise, performance-test pumps in accordance with ANSI/HI 14.6, with the above restrictions on motor power overload. Include in the factory tests test data for each full-speed performance requirement and any other points stipulated for this test procedure in the detailed specification. Conduct these tests with the pump inlet throttled to provide the specified NPSHA.
   b. Duplicate the test setup in the manufacturer's test facility as closely as possible to the inlet conditions in the proposed installation, using temporary baffles and other means, within the limitations of the test facility. Where centrifugal pumps are furnished with inlet elbows, inlet adapters or inlet reducers as a part of the manufacturer's scope of supply, test the pumps with the elbow, adapter, or reducer fitted to the pump and apply specified performance criteria to the complete pump assembly, including losses through any elbow, adapter, or reducer. Where submersible pumps are to be furnished with inlet nozzles and/or discharge elbows or adapters, test the pumps with these components fitted to the pumps. Apply the specified performance requirements to the complete pumping assembly including any inlet nozzles, and discharge elbows or adapters. Include in the certified test data separate readings for inlet and discharge head for each data point.
   c. Take not less than eight test points, including not less than three within plus or minus 8 percent (in terms of rated flow) of the rated condition (Condition Point A) and not less than two test points within plus or minus 4 percent of the pump's BEP at the test speed. In addition, one test point is sufficient to define head and power requirements at shutoff head.

d. Perform NPSH3 tests in accordance with ANSI/HI 14.6, paragraph 14.6.5.8.2.1, Type 1 Test except that not less than four tests should be performed at the test motor speed to completely cover the range of operating conditions specified in the detailed specification. One of the test points shall be at the BEP flow to confirm the test pump's S. The translation of test results to specified operating conditions shall be in accordance with ANSI/HI 14.6, paragraph 14.6.6.1.1 so long as the exponent used can be supported by certified test data performed on a pump of the same type, size, speed, and specific speed as that of the proposed pump. Include NPSH3 tests at both the proposed and test speeds in test data justifying the exponent, test points at BEP, and at least three other points on the test pump head/capacity curve at least 15 percentage points removed from the BEP. Use the results of the NPSH3 tests to confirm the NPSH margins for each specified operating condition as specified in paragraph 1.04F. Perform NPSH3 tests for column type (axial, mixed-flow, and vertical-turbine) pumps using the open sump/water level or closed tank/tank pressure methods described in ANSI/HI 14.6, Table 14.6.5.8.2.1. Perform NPSH3 tests for submersible wastewater pumps using the method described in Figure 11.6.8 in ANSI/HI 11.6. Extend all NPSH3 tests from 50 percent to 140 percent of best efficiency flow at full speed, or to not less than 10 percent (in terms of flow) past the flow at Operating Condition B, whichever is greater. For a given pump, if the manufacturer can provide documentation that the upper flow limit of the AOR on the right side of the pump curve is less than 140 percent of best efficiency flow, the AOR may be used as the limit for the NPSH3 test. Cause for rejection is failure to achieve specified performance or performance proposed in accepted submittal documents (capacity and head, efficiency, or NPSH3), whichever is more restrictive. Acceptance tolerances are as set forth in paragraph 1.05C.2 Performance Confirmation; Performance guarantee.

e. All test procedures shall be in strict conformance with the referenced standards. However, prediction of performance of a trimmed impeller from test data of the larger impeller will not be permitted. If trimming is required, re-test the pump. Do not allow deviations from specified operating conditions, though allowed by the referenced standards, to result in overload of the driver furnished with the equipment, nor allow such deviations to result in power requirements greater than the driver's nameplate (1.0 service factor) rating.

f. The contractor shall furnish the construction manager with not less than 2 weeks' advance written notice of the date and place of the non-witnessed tests.

g. All test results, including test logs and generated curves, shall be certified correct by the chief engineer or individual in responsible charge of the manufacturer's test facility, and shall be submitted in accordance with paragraph 1.06.

1.06 SUBMITTALS

A. Action Submittals:

1. Procedures: Section 01 33 00.
2. In addition to the material listed in the detailed specification, provide the following submittals:
   a. Documentation of successful pump designs or proposed alternatives as specified under paragraph 1.04B.1 Pump Selection. If included as part of the design, include in the documentation applications where pump cans of a similar size have been provided as part of the design.

b. A Certificate of Unit Responsibility attesting that the contractor has assigned unit responsibility in accordance with the requirements of this section and Section 43 05 11-1.02 Unit Responsibility. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.

c. A copy of this specification section and the specification sections listed for submittal in the detailed specification sections. Ensure that the specification copies are complete with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore, requested by the contractor, underline each deviation and denote by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the contractor with the specifications. Accompany the submittal with a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal is sufficient cause for rejection of the entire submittal with no further consideration.

d. A copy of the contract document control diagrams and process and instrumentation diagrams (P&IDs) relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, mark the drawing or drawings as “no changes required.” Failure to include copies of the relevant drawings with the submittal is cause for rejection of the entire submittal with no further review.

e. Documentation of certification in accordance with ISO 9001 as specified under paragraph 1.05A.

f. Predicted pump performance curves for each condition point specified showing head, power, efficiency, and NPSH3 on the vertical axis plotted against capacity on the horizontal axis. Provide curves for variable-speed pumps to demonstrate operation at speeds required to achieve the specified reduced-speed operating conditions. All curves shall clearly display the specified operating conditions and conformance with POR and AOR limits in the individual specification sections. Provide variable-speed plots showing specified operating conditions and POR limits. Plot curves at increments of not more than 5 percent speed or 50 rpm increments, whichever is less, from full speed to the lowest speed required to meet specified operating conditions. Curves for column-type pumps shall show bowl efficiency and allowances for inlet, column, and discharge head losses separately.

g. NPSH margin calculations performed for each specified operating condition in accordance with paragraph 1.04 as applicable and including the information required under paragraph 1.04F.

h. Motor submittal information as specified in Section 43 05 21. In addition, include in this information certified calculations for motor rotor and frame reed frequencies, as specified under paragraph 1.04G.

i. Complete description and sketch of proposed test setup for factory test if a factory test has been required under the detailed specification section or as required by the provisions of this section. Include in submittal material sample calculations and proposed test log format. If the contractor proposes a model test for a part or all of the specified performance tests, include in the submittal information the proposed model details and a complete description of the proposed method for comparing the model impeller profiles with the impeller profiles for the prototype pumps.

j. Drawings showing general dimensions and confirming the size of pumps, motors, drives, and specified appurtenances; piping connections; construction details of equipment (including bearings and bearing isolators); wiring diagrams; and weight of equipment.

k. Variable-speed drive information as required under Section 26 29 23 if the equipment specified includes variable-speed capability.

l. Driver unit support calculations and data if the driver is separately supported.

m. Shaft deflection calculations for volute-type pumps: provide calculations to demonstrate compliance with paragraph 1.04E, per the methodology set forth as required by paragraph **Error! Reference source not found.**.

n. Detail drawings of the pump and driver unit foundation demonstrating conformance to this section and Section 43 05 13. Include in the submittal drawings depicting type, size, number, projection, and arrangement of anchor bolts; dimensional drawings of the sole and baseplates; and dimensional drawings for the concrete supports for both the pump and motor, if applicable. Drawings shall also depict other pertinent information, including location of equipment pads and reinforcement; equipment drains; expansion joint locations; elevation of top of grout and grout thickness; elevation of top of baseplate, soleplate, or mounting block; size and location of electrical conduits; and any other equipment-mounting features embedded in equipment pads.

o. Limiting nozzle loading criteria, if different from that established by ANSI/HI 9.6.2.

p. The qualifications of the personnel proposed by the contractor to perform field alignment procedures in accordance with the requirements of paragraph 3.03.

3. The following are applicable to all vibration testing of pumps, in accordance with the requirements of paragraph 3.05 Field Vibration Tests:

a. The qualifications of the independent testing laboratory and individual personnel proposed by the contractor to perform field vibration testing, analysis, and reporting.

b. Proposed vibration testing plan. including accelerometers mounting and presentation formats.

B. Informational Submittals

1. Procedures: Section 01 33 00:

a. Performance guarantee as specified in paragraph 1.05C.

b. Equipment anchor calculations specified in paragraph 1.04E.

c. O&M information specified in Section 01 78 23.

d. Motor information submittals as specified in Section 43 05 21.

e. Bearing L-10 life calculations.

f. Provide critical speed calculations demonstrating compliance with paragraph 1.04C.
g. Nozzle loading information required under paragraph 3.01.
h. Motor balance logs, certified and notarized as specified in paragraph 1.04G.
i. Certified balance logs and worksheets, as specified in paragraph 2.05.
j. Installation certification Section 43 05 11-Form A as specified in paragraph 3.01.
k. Training certification Section 43 05 11-Form B as specified in paragraph 3.06.
l. If factory tests are specified in the detail specification section, certification of satisfactory testing of each unit as specified. Include in the certified material copies of test logs and resulting performance curves.
m. Documentation of field alignment data in accordance with Section 43 05 14.
n. Field vibration test reports in accordance with paragraph 3.05.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
1. Where this section and sections referencing this section are silent with respect to materials of construction on any component, material selection shall follow the requirements of Table H.1, ANSI/API 610, Materials Class I-1, with the exception that shafts for vertical column-type pumps be 12 percent chromium stainless steel. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

B. Pumps:
1. Finish for surfaces in contact with pumped fluid:
a. Conform all pump components in contact with the pumped fluid to the following requirements.
b. Indicate surfaces to be machine-finished on the shop drawings by symbols that conform to ANSI B46.1, Surface Texture, Surface Roughness, Waviness, and Lay. Machine surfaces shall be finished to at least the following tolerances:
c. Nominal roughness:

Surface	Grade, Ref: ANSI B46.1 (SI units microns) (Ra: micro inches)
General machine work	3.2 or better (125 Ra)
Flange faces	3.2 or better (125 Ra)
Journal surfaces at sleeve bearings	0.4 or better (16 Ra)
Hydraulic surfaces	
Impeller	4.5 or better (177 Ra)
Impeller bowl and diffuser	6.3 or better (250 Ra)
All other wetted surfaces	6.3 or better (250 Ra)

d. Flaws such as scratches, ridges, holes, peaks, cracks, or checks that will make the part unsuitable will be cause for rejection. Machine-finished surfaces shall be thoroughly cleaned and coated with a protective layer of rust preventive. Oil and wrap small pieces, unassembled pipe, or finished bolts with moisture-resistant paper.

2. Materials:

a. Unless otherwise specified, wetted cast-iron parts for pumps for solids-bearing liquid services shall have 2 to 3 percent nickel added to the cast iron.

b. Provide stainless-steel impellers for the first stage of custom-engineered pumps, pumps intended for pumping screened or unscreened wastewater, and elsewhere when specified. Stainless-steel impellers shall be ASTM A743, Grade CA6NM. Where cast-nickel aluminum bronze impellers are specified, the materials shall conform to ASTM B148, Alloy C95500.

c. Materials for shaft sleeves for packed boxes, fretting seals, and interstage seals shall conform to ANSI/API 610, Annex H 12 percent chromium-hardened or hard-faced 316 austenitic stainless steel. Materials for seal glands for packed boxes and shaft sleeves shall be AISI 316 stainless steel. Fastener parts of all types in wetted areas shall conform to ANSI/API 610, Materials Class S-5 requirements. Regardless of the seal construction, adequately size seal chambers to accommodate specified mechanical seals.

2.02 GENERAL QUALITY

A. The details of manufacture and assembly of equipment furnished under this section and referencing sections shall follow the requirements of ANSI/API 610 with respect to the following features (paragraph references, ANSI/API 610):

1. Alignment aids (paragraph 6.1.24)
2. Removal of rotating element (paragraph 6.1.25)
3. Jackscrews for assistance in alignment on baseplates and equipment supports (paragraph 9.3.8.3.2)
4. Castings (paragraph 6.12.2)

B. Provide all components or subassemblies weighing 50 pounds or more with at least one lifting eye or a provision for threading in a lifting eye. Provide components 250 pounds or greater with lifting eyes or provisions for at least two lifting eyes. Provide components 1,000 pounds or greater with at least three lifting eyes or provisions for inserting lifting eyes.

2.03 BASEPLATES AND SOLEPLATES

A. Unless otherwise noted in the detailed specification, the pump manufacturer shall furnish pumps with baseplates or soleplates conforming to the requirements of Section 43 05 13. Design baseplates and soleplates to be installed in the housekeeping curb shown and machine flat and co-planar to within 0.002 inch per foot in all directions on the face mating with the pump and motor or driver support. Soleplates shall have the words “THIS SIDE DOWN” permanently affixed to the underside using a welding rod material or stamped prior to milling. Alternative marking methods, using heavy scribing or machining, are acceptable provided that they may be observed following blasting in preparation for coating.

2.04 WEARING RINGS

A. Where specified, fit pumps with both stationary and rotating wearing rings. Except for the difference in hardness between stationary and rotating rings, wearing rings shall be stainless steel and conform to the requirements of ANSI/API 610, paragraph 6.7 and material class S-8 (Table H.1, Annex H). The maximum wearing ring clearances shall not exceed 150 percent of the values stated in Table 6, ANSI/API 610. The minimum wearing ring hardness on the rotating ring is 350 Brinell Hardness Number (BHN), with the stationary ring not less than 100 hardness points greater.

B. L-form wearing rings are not acceptable for wastewater, sewage, stormwater, thickener overflow, mixed sludge, digester circulation, digested sludge, waste activated sludge (WAS), RAS, or primary effluent pumping service.

2.05 BALANCE

A. The balancing for pumps with suction nozzle sizes 6 inches in diameter and greater and associated components shall conform to the requirements set forth in ANSI/API 610, paragraph 6.9.4.1 (equivalent to ISO 1940 or ANSI 2.19 Grade 2.5), unless other portions of this project manual impose more restrictive requirements. It is the intent that the components be balanced as an assembly ("rotor") in accordance with ANSI/API 610 definitions. For extended-shaft pumps, balance impeller(s) and shaft up to the first coupling with the line-shaft.

B. For separately balanced components, perform a residual unbalance inspection after rotor assembly per ANSI/API 610 requirements, as described in Annex J of that document. Provide copies of worksheets and demonstrate that tolerances are in compliance (i.e., rotor has passed) in addition to other reporting requirements of this paragraph.

C. Furnish all balance logs, certified correct and signed by the chief engineer or individual in responsible charge of the manufacturing facility, in accordance with paragraph 1.06.

2.06 DRIVE UNIT SUPPORTS FOR SEPARATELY SUPPORTED MACHINES AND INTERMEDIATE SHAFT SUPPORTS

A. Supports for separately mounted vertical pump drivers and intermediate shaft bearings shall be composite structures of fabricated steel, ASTM A36. Unless otherwise specified, design the supports to span an opening in the floor sufficient to allow removal for the complete pump. Provide rolled steel beams to stiffen the support and mount a fabricated steel driver unit support pedestal on the support plate. The support pedestal top plate and portions of the support plate assembly intended to join with surfaces in the installation structure shall be milled flat and parallel to 0.002 inch per foot. Provide pedestals with access provisions to adjust or assemble/disassemble couplings. Select a support that is designed to be supported on a soleplate or soleplates embedded in a housekeeping pad at the edges of the floor opening or as indicated. Other details for the driver unit support shall be as indicated.

2.07 MACHINING

A. Unless otherwise specified, provide machined surfaces with a 125 Ra (micro-inch) finish without any grooves, surface imperfections, or machining marks. Mating surfaces shall be coplanar within a maximum of 0.002 inch. Bearing housings and seals shall have collinear centerlines within less than 0.001-inch total difference. Provide shafts with a 63 Ra (1.6-micron) finish at fit areas (coupling, sleeves, impeller) and 125 Ra (3.2-micron) finish at the clear spans.

PART 3 EXECUTION

3.01 GENERAL

A. With the exception of submersible pumps and the inlet connection for column-type pumps installed in open forebays or wetwells, connect pump inlet and discharge nozzles to field piping using equipment connection fittings conforming to the requirements of Section 40 05 06.16 or as otherwise shown on the drawings. Select restraining rods on equipment connection fittings that is designed specifically to restrain the unbalanced hydraulic thrust developed by the pump when operating at full speed against a closed valve. Torque all restraining rod nuts to ensure that any moment or shear transmitted to the pump nozzles is within the values permitted under ANSI/HI 9.6.2, or that permitted by the equipment manufacturer, whichever is greatest. Where ANSI/HI 9.6.2 is silent with respect to any particular aspect of allowable nozzle loads, the contractor shall follow the written requirements provided by the equipment manufacturer. Equipment installation procedures shall conform to the requirements of Section 43 05 13. Upon completion of installation work, the contractor shall submit a complete, properly signed certification Form 43 05 11-A as specified in Section 01 99 90.

3.02 SOLEPLATES

A. Level soleplates, if provided pursuant to this section or any section referencing this section, or where required by the equipment manufacturer's recommendation, in the presence of a factory-authorized installation specialist to a maximum tolerance of 0.002 inch per foot in all directions. Where the equipment manufacturer requires more stringent tolerances, those tolerances prevail.

3.03 ALIGNMENT

A. Journeymen millwrights shall perform alignment of equipment furnished under this section and any referencing section. Carpenters, laborers, or any other trades are specifically excluded from performing this work. In locations where such trades are not available, the contractor shall retain the services of a firm specializing in this type of work to perform the setting and alignment work. The contractor shall submit the qualifications of the proposed firm to the construction manager for acceptance prior to performing the work. The construction manager shall personally witness the final alignment procedures for each item of equipment as a condition precedent to beginning any work required under Section 01 45 20. Alignment techniques shall conform to the requirements of Section 43 05 14.

3.04 FIELD TESTING

A. Field testing shall conform to the requirements of Section 01 45 20 and the detailed specification sections.

B. the testing procedure is a plan developed jointly by the contractor and equipment manufacturer to demonstrate performance of each item of equipment at specified operating conditions.

C. Unless otherwise specified in the detailed specifications, field-test centrifugal pumps for lateral vibration in accordance with paragraph 3.05B.

3.05 FIELD VIBRATION TESTS

A. Qualifications:
   1. The contractor shall retain the services of an independent testing laboratory to conduct the testing work specified under this paragraph. The work shall be directed by a professional mechanical engineer, registered to practice in any one of the 50 states composing the United States.
      a. The engineer (hereinafter termed “professional vibration analysis specialist”) shall be a graduate of a college holding Accreditation Board for Engineering and Technology Inc. (ABET) accreditation in mechanical engineering and has been engaged in the practice of providing the type of monitoring services required under this paragraph for rotating machinery for a period of not less than 10 years.
      b. As an alternate qualification, the professional vibration analysis specialist shall have an ISO/ANSI Vibration Analyst Category IV and been engaged in the practice of providing the type of monitoring services required under this paragraph for rotating machinery for a period of not less than 10 years.
   2. Submit the professional vibration analyst specialist’s qualifications and references, certified and notarized, for review and acceptance by the construction manager not less than 6 weeks prior to the date scheduled for the field vibration test work specified herein. The construction manager shall review the required documentation and references and indicate acceptance or rejection of the proposed analyst’s qualifications within 14 days of submission. If the analyst proposed by the contractor is rejected, the contractor shall propose an alternative choice with appropriate documentation.
   3. The independent testing laboratory’s testing team (comprising the professional vibration analysis specialist and any technicians required to complete the specified tasks) shall be fully equipped to provide continuous pressure, velocity, and displacement values for rotating equipment installed under the requirements of this section. Vibration testing equipment shall include sufficient calibrated pressure and flow monitoring devices to determine pump operating conditions and vibration levels.

B. Vibration Tests:
   1. Submit vibration testing plan, prepared by the professional vibration analysis specialist, for review and acceptance by the construction manager not less than 3 weeks prior to the date scheduled for the field vibration test work specified herein.

a. Proposed vibration testing plan, incorporating corresponding pump performance testing, shall be developed to demonstrate absence of natural frequency excitation (resonance) and compliance with specified vibration limits within the pump operating range.
b. The professional vibration analysis specialist shall consider identified standards and others consistent with practice standards of care in preparing the plan and directing the work.
c. As part of the plan, professional vibration analysis specialist shall specify and justify selection and mounting of the vibration sensors (fully adhered or magnet-mounted) in accordance with accepted practice and specified requirements. Hand-held probe accelerometers shall not be used.
d. Plan shall also stipulate the data collection and processing method including frequency response averaging of spectra and waveform points for each discrete measurement.
e. Include example presentation formats consistent with specifications and accepted practice.

2. Unless otherwise specified in the detailed specification, the RMS vibration velocity shall not exceed the limits established in the appropriate standards indicated in the Table below. The measurement locations shall correspond to the guidelines provided in the specific standards given in the Table below.

Component	Standard
All Pumps	ANSI/HI 9.6.4 or ANSI/HI 11.6
Electric Motors	ISO 10816-3 Table A.1 or A.2, Zone Boundary A/B

3. Testing:

a. Perform ramp (sweep) test of pump vibrations (at average or higher head conditions) – minimum 10 minutes (mins) start-up run, slow ramp from minimum to maximum speeds (20 mins). 20 mins at maximum speed, 10 mins at reduced (A operating speed), 10 mins to confirm largest peak; then through coast down.
b. The professional vibration analysis specialist shall collect vibration readings during the sweep test, make notes about peaks and then proceed to testing with steady state operation at the design and other targeted points. Prepare report of Overall Velocity Trends including pump speed and flow.
c. Conduct discrete performance and vibration testing of all design points (4), when performance is stable but not less than 10 minutes each. It is not necessary to conduct vibration testing at shut-off.
d. Conduct similar discrete performance and vibration testing at each discrete peak observed during the sweep test.

4. Reporting:

a. Provide vibration test reports as an information submittal in accordance with paragraph 1.06, and provide the signature of the responsible professional vibration analysis specialist.

b. The vibration spectra shall be of sufficient resolution for legibility of magnitude and frequency data to be properly reviewed by the construction manager. Cascade diagrams are not sufficient for variable-speed drive application unless supported by the required data in a format suitable for more detailed analyses. Provide separate spectra at the maximum and minimum operating speeds and any potential resonant frequencies.

c. Depict RMS velocity by axis on same plot and zoom in on 10 highest peaks for each separate axis. Report should clearly address multiples of operating speed and twice vane pass at operating speed, typically associated with pump phenomena.

d. Interpret data, identify anomalies and resonant frequencies (if any), provide discussion of probable sources/causes in test report. Provide interpretation as to why there may be peaks beyond typical phenomena.

e. If deemed necessary by the professional vibration analysis specialist, to determine the potential problem and risk with any identified peaks, further resolve and analyze critical peaks by frequency.

C. Remedial Measures:

a. If required, professional vibration analysis specialist shall provide written recommendations for remedy of problems identified.

b. Contractor shall undertake appropriate remedial action, in conjunction with the pump manufacturer, and provide professional vibration analysis specialist services, and pump manufacturer services throughout the process required to resolve identified problems.

c. Conduct additional testing after modifications or replacements to confirm effectiveness of remedy.

3.06 TRAINING

A. Training shall conform to the requirements of Section 01 79 00 and include separate training sessions for each operator shift maintained by the Owner and a separate session for maintenance personnel.

B. Unless otherwise specified in the referencing section, the training requirement is waived for constant-speed pumping equipment with suction nozzle sizes 6 inches in diameter and smaller and for pumps with connected power requirements 10 hp and less.

C. The training session for maintenance personnel shall include a comprehensive presentation, employing cut-away models or comparable graphics, and documentation on the step-by-step disassembly and subsequent reassembly of a pumping unit.

D. Upon completion of training requirements, the contractor shall submit certified Form 43 05 11-B as specified in Section 01 99 90.

END OF SECTION

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SECTION 43 23 80.12

SUBMERSIBLE PUMPS – CONSTANT SPEED, WATER TREATMENT, SMALL APPLICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Scope:
   1. This section specifies submersible pumps suitable for pumping unscreened wastewater at constant speed. Pumps furnished under this specification shall have discharge nozzles from 2 through 3-1/2 inches in diameter and motors less than 7.5 horsepower.
   2. Pumps will be installed in a wet-pit configuration.
   3. Pump units shall be complete with motor, discharge fitting, guide bar and brackets, chain and cable hooks and other accessories as specified.
   4. Manufacturers proposing to furnish equipment specified under this section shall hold current certification under ISO 9001-2001. Application for certification under ISO 9001 shall not be deemed as an acceptable substitute for current certification. Documentation attesting to current certification shall be signed by an officer of the manufacturer's corporation and shall be notarized.

B. Type:
   1. Pumps shall be of the submersible, vertical shaft, centrifugal nonclog type, suitable for pumping fluids containing unscreened wastewater solids. The pumps shall be designed for continuous or cyclic operation under submerged, or partially submerged without damage to the pump and motor. Special attention shall be devoted to the shaft design to limit deflection under all operating conditions, as specified in this section.

C. Equipment List:

Item	Equipment Number
Decant Pump 1	P4051
Decant Pump 2	P4052
Plate Settler Feed Pump 1	P7011
Plate Settler Feed Pump 2	P7012
Settled Backwash Solids Pump 1	P7021
Settled Backwash Solids Pump 2	P7022
Recycled Backwash Water Pump 1	P7031
Recycled Backwash Water Pump 2	P7032

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 08 31 20 Floor Access Doors
   2. Section 43 05 11 General Requirements for Equipment

3. Section 43 05 13 Rigid Equipment Mounts
4. Section 43 05 21 Common Motor Requirements for Equipment

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
ASTM A48	Gray Iron Castings
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
UL 674	Motors and Generators, Electric, for Use in Hazardous Locations, Class I, Groups C and D, Class II, Groups E, F, and G

1.04 ADMINISTRATIVE REQUIREMENTS

A. Unit Responsibility:
   1. Assign unit responsibility, as specified in Section 43 05 11, to the manufacturer of the vertical, nonclog submersible pumps provided for all equipment and accessories under this section. Have all mechanical equipment components, at least, of this entire equipment assembly furnished by the pump's manufacturer. Provide a completed, signed, and notarized Certificate of Unit Responsibility (Form 43 05 11-C, Section 01 99 90).

1.05 SUBMITTALS

A. Action Submittals – Shop Drawings:
   1. Procedures: Section 01 33 00.
   2. A copy of this Section, addendum updates included, along with the sections listed below shall be submitted with each paragraph check-marked to indicate compliance or marked to indicate requested deviations.
      a. This Section (43 23 80.11)
      b. Section 43 05 11 – General Requirements for Equipment
      c. Section 43 05 13 – Rigid Equipment Mounts
      d. Section 43 05 21 – Common Motor Requirements for Equipment
   3. The specification copies shall be complete with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each

deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

4. A copy of the contract document control diagrams E-00-523 and process and instrumentation diagrams I-40-102 and I-70-101,102, and 103 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
5. Unit Responsibility Certification form (Form 43 05 11-C) attesting that unit responsibility has been assigned in accordance with the requirements of this Section and Section 43 05 11. No other submittal material will be reviewed until the certificate has been found in conformance with this requirement.
6. Predicted pump performance curves for each condition point specified showing head, power, efficiency, and NPSH3 on the ordinate plotted against capacity on the abscissa. All curves shall clearly display the specified operating conditions, POR and the manufacturer's limits for the AOR.
7. Drawings showing general dimensions and confirming the size of pumps, motors, drives and specified appurtenances; piping connections; construction details of equipment (including bearings and bearing isolators); wiring diagrams; and weight of equipment.
8. Manufacturer's data including materials of construction and equipment weight.
9. Manufacturer's operation and maintenance information in accordance with Section 01 78 23.

B. Informational Submittals:
   1. Written factory tests report, as specified in paragraph 2.08.
   2. Installation certification in accordance with Paragraph 3.03.
   3. Training certification in accordance with Paragraph 3.03.

C. Closeout Submittals:
   1. Operating and maintenance submittals:
      a. Procedures: Section 01 78 23.
      b. Include final reviewed shop drawings submittal.
   2. Spare parts:
      a. Procedures: Section 43 05 11. Provide the following spare parts for each model and size of pump furnished for this Section:
         1) One complete set of all gaskets and seals
         2) One complete sets of all bearings
         3) One complete set of mechanical seals
         4) One complete set of discharge connection sealing devices
         5) One complete spare pump.

1.06 QUALITY ASSURANCE

A. Vibration Limits: Vibration limits for submersible pumps shall be in accordance with ANSI/HI 11.6.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00

B. Block shaft and prevent damage to bearings during shipment

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. The manufacturer's standard product may require modification to conform to specified requirements:
   1. Grundfos
   2. Xylem-Flygt
   3. Wilo-EMU
   4. Fairbanks-Nijhuis
   5. Approved Equal

2.02 TYPE

A. Submersible, vertical shaft, centrifugal nonclog type, suitable for pumping fluids containing water solids.

2.03 PERFORMANCE/DESIGN CRITERIA

A. Service Conditions:

Area exposure	Non Hazardous
Fluid type	Wastewater from membrane treatment and GAC Backwash Water
Fluid temperature	40 to 75 degrees F

B. Operating Conditions:
   1. The performance requirements presented in tabular form below are intended to describe the results of hydraulic calculations developed using a mathematical modeling program specifically developed for the purpose. The model was intentionally used to develop the limits of expected extremes in variation of static head, coefficients for pipeline resistance and turbulence losses through fittings and valves.
   2. Equipment furnished under this section shall be fully suitable for continuous operation at any specified condition or any condition lying between the extremes of the operating conditions specified in the following table. The total head in the information below is the total system head at the operating capacity, essentially a summation of the head of the two pumps at that capacity. The notes presented at

the end of the table are intended to be complimentary to the information presented in the table.

C. Table of Operating Conditions:

Equipment number	P4051 P4052 P7011 P7012 P7021 P7022	P7031 P7032
Condition A [1,3]		
Capacity, gpm	120	125
Total head, feet	15	57
NPSHA, feet	38	38
Condition B [2,3]		
Capacity, gpm	H/Q Curve	H/Q Curve
Total head, feet	14	53
NPSHA, feet	32	32

Notes:

1. *Condition A shall be taken as the rated, continuous-duty operating condition. Performance at the rated condition shall be guaranteed in accordance with Section 43 23 03. Condition A has been selected to obtain the rated pumping capacity for the installation. It is not intended that the pumps be selected for maximum efficiency at Condition A. Pumps furnished under this section shall be selected to achieve Condition A performance, and also shall operate continuously without objectionable vibration or cavitation at the head specified under Condition B. Condition A may be located in the Allowable Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and published in the manufacturer's published application data for the specific model proposed for this application.*
2. *Condition B head is presented to indicate operating conditions when the pump is operating against minimum anticipated system head, assuming a hypothetical head-capacity curve. Condition B shall be used for pump selection. Condition B shall be located within the Preferred Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application. Condition B shall be located to the right of BEPQ and shall be not less than 110 percent of BEPQ. Pumps with head-capacity curves steeper than that assumed will produce somewhat less flow at somewhat lower head. The reverse will occur with pumps having a shallower head-capacity curve.*
3. *Total head in the above tabulation is the algebraic difference between the discharge head and suction head as defined in ANSI/HI 1.1 through 1.6. Net positive suction head available (NPSHA) in the above.*

D. Design Requirements:

Equipment number	P4051 P4052 P7011 P7012 P7021 P7022	P7031 P7032
Pump		
Rigid sphere, inches diameter (min.), capable of passing through the pump from inlet to discharge (Impeller Alternate 1/Alternate 2)	1.5	1.5
Minimum efficiency at best efficiency point (BEP) at maximum speed, percent [1]	35	35
Piping connection size, inches, minimum	3	3
Pump inlet	3	3
Pump discharge	3	3
Operating speed, rpm, maximum	1,800	3600
Operating speed, constant or variable	Constant	Constant

Equipment number	P4051 P4052 P7011 P7012 P7021 P7022	P7031 P7032
Suction specific speed, dimensionless, maximum[2]	8,500	8,500
Motor		
Horsepower	2	2
Type	Submersible	Submersible
Over temperature protection	Yes	Yes
Moisture sensors	Yes	Yes
Operating speed, rpm, maximum	1,800	3600
Voltage/Phase	460 VAC, 3 Phase	460 VAC, 3 Phase

Notes:

1. *The minimum acceptable efficiency at best efficiency point (BEP) at the speed required to achieve the performance specified under Condition Points A and B. The minimum acceptable efficiency is not necessarily required to be associated with any operating condition specified in Paragraph 2.03 Operating Conditions.*
2. *The suction specific speed limitation listed applies only to pump selections where both Operating Conditions A and B reside within the proposed pump selection's POR. Proposed selections with Operating Condition A residing in the AOR shall be limited to designs with suction specific speed less than 8500. Suction specific speed shall be calculated for the maximum pump design speed and impeller diameter, using the capacity in gallons per minute and NPSH3 at Best Efficiency in accordance with the procedures set for in the standards of the Hydraulic Institute.*

2.04 SYSTEM OPERATION

A. The pumps will be operated by a control system that will start and stop the pumps at constant speed Periodically, the control system will be overridden permitting the basin level to be drawn down until the pumps break suction.

B. The pumps will be installed in a reinforced concrete structure designed to provide sufficient space for access to install and remove the equipment.

2.05 MATERIALS

A. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

B. Provide materials of construction in accordance with the following table:

Component	Material
Pump and motor casing	
Rated head < 100 feet	Cast iron, ASTM A48, Class 30 or 35
Rated head > 100 feet	Cast ductile iron, ASTM A 536, Class 65-45-12
Discharge elbow	Cast iron, ASTM A48, Class 30 or 35
Impeller	Cast iron, ASTM A48, Class 30 or 35 or ASTM A532-IIIA
Motor and pump shaft	Stainless steel, ASTM A276 Type 329, 403, 416, 420 or ASTM A479 Type 403, 431
Wearing rings	Stainless steel, ASTM A276 Series 440B or Cast duplex stainless steel, ASTM A890 Grade 1B or 5A
External bolts and nuts	Stainless steel, ASTM A276 Type 316
Guide bar brackets	Stainless steel, ASTM A276 Type 316
Anchor bolts	Stainless steel, ASTM A276 Type 316
Guide rails, lifting assemblies	Stainless steel, ASTM A276 Type 316

2.06 COMPONENTS

A. Pumps and Motor Casing:

1. Casings shall be constructed of corrosion resistant cast iron and shall be designed to allow removal of all rotating parts from the motor end of the pumps. All mating surfaces where watertight sealing is required shall be machined and fitted with nitrile O-rings. Casing shall be fitted with moisture sensor specifically designed to detect the presence of water in the seal chamber.

B. Impellers:

1. Alternate 1: The impeller shall be dynamically balanced with a non-clogging design capable of passing solids, fibrous materials, heavy sludge, and other matter found in normal sewage applications through to the discharge nozzle. Impellers for pumps with discharge nozzles 4 inches in diameter and greater shall be not less than two-vane design. Fit between the impeller and the shaft shall be a sliding fit with a taper-lock bushing pressed by a screw that is threaded into the end of the shaft, or a slip fit onto the shaft and drive key and fastened to the shaft by an impeller nut having cover for protection from pumped fluid. A wearing ring system designed for abrasion resistance shall provide efficient sealing between the volute and impeller.
2. Alternate 2: The impeller shall be dynamically balanced, semi-open, multi- vane, back-swept, non-clog design. The impeller vane leading edges shall be mechanically self-cleaned upon each rotation as they pass across a spiral groove located on the volute suction which shall keep them clear of debris, maintaining an unobstructed leading edge. The impeller(s) vanes shall have screw-shaped leading edges that are hardened to Rc 45 and shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in waste water. The screw shape of the impeller inlet shall provide an inducing effect for the handling of sludge and rag-laden wastewater. Impellers shall be locked to the shaft and shall be coated with alkyd resin primer.

C. Bearings:

1. Bearings shall be heavy-duty permanently lubricated ball type. Bearings shall be designed for an L-10 life of 50,000 hours heavy-duty service without requiring additional lubrication.

D. Shaft:
   1. The pump shaft shall be turned, ground and polished, of proportions suitable for use in the specified application. The shaft shall be of sufficient section to limit deflection at the shaft seal to not more than 4.0 mils when the pump is operating at any continuous-duty point defined by the envelope of conditions specified in this Section.

E. Mechanical Seals.
   1. Provide tandem or dual mechanical seals per the following requirements:
      a. Dual cartridge
      b. High capacity barrier fluid ports
      c. Self-centering, non-fretting
      d. Springs isolated from the both process and barrier fluids
      e. Pressure Rating: 250 psig
      f. Stationary Face: silicon carbide
      g. Rotary Face: silicon carbide
      h. Metal Parts: Type 316 stainless steel
      i. Springs: Hastelloy C
      j. O-Rings: fluorocarbon
      k. Candidate Product: Chesterton 255 or approved substitute

F. Temperature Sensors:
   1. The stator shall be equipped with three thermal sensors, embedded in the end coils of the stator winding (one sensor in each stator phase). These shall be wired to the specified motor protection relay for motor protection.

G. Moisture Detection:
   1. Provide motors with a moisture detection system.
      a. A primary moisture detector shall be provided in the stator housing leakage chamber.
      b. A second moisture detector shall be located in the motor junction box or inspection chamber.
   2. All moisture detectors shall be wired to the motor junction box for connection to the specified motor protection relay.
   3. Moisture detectors shall be either mechanical float switch or capacitance probe type as recommended by the manufacturer.

H. Motor:
   1. The pump motor shall be a squirrel-cage induction, shell type design, housed in an air-filled or an oil-filled, watertight chamber, NEMA B type with a service factor of 1.15 based upon nameplate rating. The manufacturer shall furnish an unqualified warranty guaranteeing (full replacement at no cost to the City) the performance of the motors furnished under this project for a period of five years when operating under the specified conditions.

2. The stator winding and stator leads shall be insulated with moisture resistant Class H insulation, which shall be rated at a temperature of 180 degrees C. Motor shall be provided with thermal sensors to protect the motor from excessive heating. Thermal sensors shall be as specified in this Section. The temperature rise of the motor shall not be in excess of that specified in NEMA MG-1 for class B insulating materials when operating continuously under load.
3. The motor shall be designed for continuous duty in air and in 95 degree Fahrenheit water, capable of sustaining a minimum of 10 starts per hour when operated with.
4. The junction chamber, containing the terminal board, shall be hermetically sealed from the motor. Connection between the cable conductors and stator leads shall be made with threaded compressed type binding post permanently affixed to a terminal board.

I. Motor Protection Relay:
1. Provide motor protection relay to protect motor from high temperature and moisture, for installation in the motor controller per Section 26 29 13.
2. During normal pump operation, the temperature switch shall be closed and the leakage switch shall be normally open. Sensor circuit shall operate on 12 or 24 VDC feed from the main relay body. The relay shall be provided with LEDs to indicate status of relay on face for leakage, temperature, and supply voltage.
3. Latch detection of open temperature switch. An external reset shall be required to clear alarm. Retain relay state during power failures for temperature.
4. Moisture detection shall auto reset.
5. Power supply shall be 120 VAC.
6. Provide one SPDT contact for remote over-temperature alarming. Provide one SPDT contact for remote moisture detection alarming.
7. Relay shall be UL or UR approved, suited for panel installation.
8. Relay shall be mounted inside the associated pump's motor controller panel. Mounting shall be DIN rail mount or back panel mount. Coordinate to provide relay for installation at the shop where the associated motor controller is being fabricated. Coordinate size, wiring, and mounting of the relay into the motor controller.
9. Relay manufacturer shall be Xylem-Flygt, ATC Diversified Electronics, Dwyer, or approved substitute.

J. Cable:
1. Cable:
a. The pump shall have two cables. One cable shall be for power, and one cable shall be for control (the motor thermal sensors and moisture detector). The cable design shall be suitable for installation in a municipal water pumping station. The cable length shall not exceed the product manufacturer's recommended length. The Contractor shall be responsible for determining the length of cable required to wire the motors and sensors from the wet well to the terminal boxes. The Contractor shall provide additional cable length for slack to allow the pumps to be removed from the wet well. The length of cable for slack shall be based on the pump manufacturer's recommendation.

2. Cable Seal:
    a. The cable entry water seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall be comprised of individual cylindrical elastomer clamps having a close tolerance fit against the cable conductor insulation and the entry inside diameter and compressed by the entry body containing a strain relief function, separate from the function of sealing the cable. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland, potting chamber or terminal board, which shall isolate the motor interior from foreign material gaining access through the pump top. If a potting chamber is used, the potting procedure shall employ an epoxy-potting compound combined with a procedure that insures penetration of the compound into the individual cable conductor strands to prevent development of wicking pathways for entrance of water into the motor.
3. Cable Disconnection:
    a. The pump shall be designed such that power/ control cable can be removed from the pump motor without breaking the cable seal. The power/ control cable shall be sealed to a removable motor chamber cap that shall be universally mateable to the same manufacturer's pump series. The pump shall be able to be removed from the wet well and disconnected from the cable by removing the motor chamber cap. A spare removable chamber cap with 15 feet of cable shall be provided.

K. Guide Rail Lifting System and Discharge Elbow:
1. The pump shall be provided with a dual guide rail system to allow easy removal of the pump without entering the wet well. The discharge connection shall be bolted to the structure as required by the pump manufacturer and shall serve as a lower attachment for the guide rails. The discharge connection shall be an elbow discharge type.
2. The pump and guide rail system shall be designed to automatically connect the pump to the discharge piping when lowered into place on the discharge connection. The design shall be non-sparking and shall conform to UL requirements for installation in a location classified in accordance with NFPA 70, Article 500 for Class 1, Group D, Division 1 locations. When in place, the connection shall form a watertight seal with the discharge fitting. The pump shall be easily removable for inspection or service, requiring no bolts, nuts, or other fastenings to be removed for this purpose. Sealing of the pumping unit to the discharge connection shall be accomplished by a simple linear downward motion of the pump with the entire weight of the pumping unit guided to and pressing tightly against the discharge connections. No portion of the pump shall bear directly on the floor of the sump and no rotary motion of the pump shall be required for sealing. Once the pump has been positioned on its support fitting at the discharge fitting, the guide bar system shall not be required for pump support.
3. The pump shall be provided with a lifting chain, guide bars, upper guide bar brackets, intermediate guide bar brackets, cable holder assemblies, safety chain hook assemblies, discharge elbow connections, anchor bolts, and all other accessories necessary to complete the installation as specified. The lifting chain length shall equal the depth of the sump.

L. Level Instruments:
   1. Provide level instruments to meet the pump control operation requirements defined in this section. Level instruments shall meet the requirements of Section 40 06 70 with the device type meeting requirements of Section 40 72 00. Provide cable of sufficient length to reach the control panel from the sump.

2.07 EQUIPMENT AND SYSTEM CONTROLS

A. Section 26 29 13 specifies control system requirements.

2.08 FINISHES

A. Provide a ANSI/NSF-61 Certified Coating suitable for abrasive applications.

2.09 SOURCE QUALITY CONTROL

A. Factory Tests:
   1. Factory tests will not be required. However, the manufacturer shall guarantee the performance specified under paragraph 43 23 80.12-2.03, Condition A.

PART 3 EXECUTION

3.01 COATINGS

A. See Paragraph 2.08.

3.02 FIELD QUALITY CONTROL

A. Procedures: Section 01 45 20 and Section 01 91 00.

B. Perform the following test:
   1. Performance Test
      a. Using clean water, measure pump flow and discharge pressure. Verify pump flow and discharge pressure is within the range of specified operating conditions.
      b. Temporary flow meters and pressure gauges will be required.
      c. Throttle valve on pump discharge as necessary to achieve specified pump pressure within specified operating range.
      d. Test level controls to verify pump control system operates as specified in this Section.

3.03 MANUFACTURER'S SERVICES

A. On-Site Inspections and Training: Provide a factory-trained manufacturer's representative at the Site for the following activities. Specified durations do not include travel time to or from the Site.
   1. Installation Inspections: Assist, supervise, and inspect the Contractor's activities during installation of submersible sump pumps. Provide 4 hours of installation inspection during installation of each submersible sump pumps.
   2. Training Sessions: Procedures Section 01 79 00. Provide 2 hours of classroom training. Complete Form 43 05 11-B, Section 01 99 90.

END OF SECTION

SECTION 43 23 89.13

ANSI HORIZONTAL, VARIABLE SPEED, END SUCTION, FRAME MOUNTED CENTRIFUGAL PUMPS

GENERAL

1.01 SUMMARY

A. This section specifies horizontal, end suction, frame mounted centrifugal pumps for pumping raw water. Pumps shall conform to ANSI/ASME B73.1.

1. Equipment furnished under this section shall conform to the requirements of this section and to the requirements in Section 43 23 03.

B. Equipment List:

Item	Equipment Number
Raw Water Feed Pump 1	P2110
Pump 1 VFD	VFD2110
Raw Water Feed Pump 2	P2120
Pump 2 VFD	VFD2120

1.02 RELATED SECTIONS

1. Section 26 29 23: Variable Frequency Motor Controllers
2. Section 43 05 11: General Requirements for Equipment.
3. Section 43 05 13: Rigid Equipment Mounts
4. Section 43 05 14: Machine Alignment
5. Section 43 05 21: Common Motor Requirements for Equipment
6. Section 43 23 03: General Requirements for Centrifugal and Axial Flow Pumping Equipment

1.03 REFERENCES

A. This section contains references to the following documents. These references are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. If requirements of this section conflict with those of the listed documents, requirements of this section prevail.

B. Unless otherwise specified, reference documents refer to documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if no Bids). If referenced documents have been discontinued by the issuing organization, refer to replacement documents issued or otherwise identified by that organization. If there are no replacement documents, refer to the last version of the document before it was discontinued. Where document dates are given in the following listing, those documents refer to the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ANSI/AME B73.1	Horizontal End Suction Centrifugal Pumps for Chemical Process
ASTM A48 –REV A	Gray Iron Castings
ASTM A216/A216M	Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
ASTM A395	Ferrite Ductile Iron Pressure Retaining Castings for Use at Elevated Temperatures
ASTM A536	Ductile Iron Castings
Hydraulic Institute Standards	Standards of the Hydraulic Institute, 14th Edition

1.04 DEFINITIONS

A. Terminology used in this section conforms to the following definitions:
   1. Equipment pad: concrete foundation (block or slab) supporting and elevating equipment mounts above the supporting structural floor slab or local grade.
   2. Mounting pads: thickened or raised areas of baseplates and soleplates where the feet or mounting surfaces of mounted equipment and drivers rest on the baseplate or soleplate.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. See Section 01 12 16 Work Sequence.
   2. Coordinate pump and motor operational and starting characteristics with adjustable frequency drive settings used for control of this equipment. Include the following:
      a. Motor minimum operational speed
      b. Motor maximum operational speed
      c. Motor ramp-up and ramp-down speed, voltage, and frequency requirements
      d. Other operating limits imposed by the driven equipment for operation and warranty.

B. Unit Responsibility:
   1. Assign unit responsibility, as specified in Section 43 05 11, to the manufacturer of the equipment package for Section 46 61 33. Assign unit responsibility to the manufacturer of the variable-frequency drive controllers specified in Section 26 29 23.
   2. Provide a completed and signed Unit Responsibility Certification Form (Form 43 05 11-C, Section 01 99 90).

1.06 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 00.

B. Action Submittals - Shop Drawings:
   1. Comply with requirements of Section 43 23 03.
   2. A copy of this specification section and the specification sections listed for submittal in the detailed specification sections. Ensure that the specification copies are complete with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) denote full compliance with a

paragraph as a whole. If deviations from the specifications are indicated and, therefore, requested by the contractor, underline each deviation and denote by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the contractor with the specifications. Accompany the submittal with a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal is sufficient cause for rejection of the entire submittal with no further consideration.

3. Sections to be marked-up and submitted in accordance with Section 43 23 03 requirements include:
    a. This section
    b. Section 43 05 11: General Requirements for Equipment
    c. Section 43 05 13: Rigid Equipment Mounts
    d. Section 43 05 14: Machine Alignment
    e. Section 43 05 21: Common Motor Requirements for Equipment
    f. Section 43 23 03: General Requirements for Centrifugal and Axial Flow Pumping Equipment
4. A copy of the contract document control diagrams E-00-521 and process and instrumentation diagrams (P&IDs) I-21-101 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, mark the drawing or drawings as “no changes required.” Failure to include copies of the relevant drawings with the submittal is cause for rejection of the entire submittal with no further review.
5. A Certificate of Unit Responsibility attesting that the contractor has assigned unit responsibility in accordance with the requirements of this section and Section 43 05 11-1.02 Unit Responsibility. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.
6. Submittal requirements of Section 43 05 21.
7. Provide coordination items required for proper setup of the variable frequency drives as specified in paragraph 1.05 Coordination.
8. Spare parts to be provided.

C. Informational Submittals:
    1. Submittals shall conform to the requirements of Section 43 23 03.
    2. Installation Certification Form 43 05 11-A as specified in paragraph 3.03.
    3. Training Certification Form 43 05 11-B as specified in paragraph 3.03.

D. Closeout Submittals:
    1. Comply with procedures described in Section 01 78 23.
    2. Provide operating and maintenance submittals as specified in Section 01 78 23. Include copy of final reviewed submittal.
    3. Spare Parts
        a. Comply with procedures described in Section 01 33 00.
        b. Provide the following spare parts:

1) One set of all pump bearings
2) One set of all pump gaskets
3) One complete mechanical seal

1.07 QUALITY ASSURANCE

A. Certifications:
   1. Manufacturers proposing to furnish equipment specified under this section shall hold current certification under ISO 9001-2001.
   2. Application for certification under ISO 9001 is not an acceptable substitute for current certification. Documentation attesting to current certification shall be signed by an officer of the manufacturer's corporation and notarized.

B. Critical Speeds:
   1. Critical speeds shall be in accordance with Section 43 23 03-1.04 except when the title of the detailed section includes "Custom Engineered" in which case Section 43 23 03-1.05 applies.

C. Vibration Limits:
   1. Vibration limits shall be in accordance with Section 43 23 03-3.06 and subject to field testing in accordance with paragraph 3.04.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Comply with procedures described in Section 01 66 00.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following candidate manufacturers are capable of producing equipment and/or products satisfying the requirements of this section. The manufacturer's standard product may require modification to conform to specified requirements:
   1. Goulds Model 3196
   2. Peerless 8196
   3. Patterson
   4. Flowserve-Durco Mark 3
   5. Approved equal

2.02 TYPE

A. ANSI horizontal, end suction, centrifugal pumps capable of variable speed.

2.03 PERFORMANCE/DESIGN CRITERIA

A. General:

1. The pump shall be designed to pump clear liquids, particles, and light slurries and operate without clogging or fouling caused by material in the pumped fluid at any operating condition within the range of service specified.
2. The pump shall be designed to operate without cavitation and the motor and pump combination shall operate without vibration over the specified range of conditions. The pump head capacity curve shall slope in one continuous curve with no point of reverse slope inflection.
3. All components shall be designed to safely withstand forces resulting from flow reversals up to 125 percent of maximum speed within the pump during shutdowns caused by power failure.
4. The complete pumping unit shall be designed to operate without overload on any component at any point along the pump's entire operating curve.
5. The complete pumping unit shall be designed to operate without overload on any component at any point along the pump's entire operating curve.

B. Service Conditions:

Description	Value
Equipment number	P2110, P2120
Area exposure	Non Hazardous
Fluid type	Surface Water
Fluid temperature	40 to 75 degrees F

C. Operating Conditions:

Equipment number	P2110, P2120
Full Speed Operation, Condition A [1, 7]	
Capacity, gpm	560.0
Total head, feet	113.2
Net positive suction head available (NPSHA), feet	46.6
Full Speed Operation Condition B [2, 7]	
Capacity, mgd	From pump H/Q curve
Total head, feet	103.8
NPSHA, feet	46.7
Reduced Speed, Condition C [3, 7]	
Capacity, gpm	200.0
Total head, feet	66.4
NPSHA, feet	59.3
Reduced Speed, Condition D-1 [4,7]	
Capacity, gpm	250.0
Total head, feet	67.2
NPSHA, feet	57.8
Reduced Speed, Condition D-2 [4,7]	
Capacity, gpm	250.0

Equipment number	P2110, P2120
Total head, feet	107.1
NPSHA, feet	46.8
Reduced Speed, Condition E [5,7]	
Capacity, gpm	560.0
Total head, feet	67.7
NPSHA, feet	58.9
Reduced Speed, Condition F-1 [6,7]	
Capacity, gpm	660.0
Total head, feet	78.4
NPSHA, feet	57.8
Reduced Speed, Condition F-2 [6,7]	
Capacity, gpm	660.0
Total head, feet	90.7
NPSHA, feet	46.8

Notes:

1. *Condition A shall be taken as the rated operating condition. Performance at the rated condition shall be guaranteed in accordance with Section 43 23 03. Condition A has been selected to obtain the rated pumping capacity for the installation. It is not intended that the pumps be selected for maximum efficiency at Condition A. Pumps furnished under this section shall be selected to achieve Condition A performance, and shall operate continuously without objectionable vibration or cavitation at the head specified under Condition B. Condition A shall be located in the Preferred Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and published in the manufacturer's published application data for the specific model proposed for this application. Condition A also represents the anticipated maximum continuous duty speed condition when operating a single membrane treatment train operation at the anticipated maximum flow rate under the highest anticipated total head. Based on meeting the additional operating conditions below, Condition A may not necessarily represent a full speed condition.*
2. *Condition B head is presented to indicate operating conditions when the pump is operating at maximum speed against minimum anticipated system head, assuming a hypothetical head-capacity curve. Condition B shall be used for pump selection. Condition B shall be located within the Preferred Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application. Condition B shall be located to the right of BEPQ and shall be not less than 110 percent of BEPQ. Pumps with head-capacity curves steeper than that assumed will produce somewhat less flow at somewhat lower head. The reverse will occur with pumps having a shallower head-capacity curve. Proposed pump selections meeting this discharge head requirement by operating the equipment at less than full speed will be rejected. NPSHA, as listed for Condition B is calculated on a pumped flow of 660 gpd.*
3. *Condition C represents the expected momentary (startup/shutdown) condition. Pumps furnished under this specification will operate for no more than 30 seconds at this condition when initiating or terminating a service cycle. The maximum anticipated number of service cycles is 2 per hour.*
4. *Condition D-1 and D-2 is the anticipated minimum and maximum (respectively) continuous duty speed condition when operating a single membrane treatment train at the anticipated minimum flow rate under the lowest and highest (respectively) anticipated total head. Pumps furnished under this specification shall be capable of sustained (24 hours per day) operation at this condition within the requirements set forth in Section 43 23 03. Condition D-1 and D-2 may be located within the Allowable Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application. Pump shall be capable of operating at both conditions without objectionable vibration or cavitation.*

5. *Condition E is the anticipated minimum continuous duty speed condition when operating a single membrane treatment train at the anticipated minimum flow rate under the lowest anticipated total head. Pumps furnished under this specification shall be capable of sustained (24 hours per day) operation at this condition within the requirements set forth in Section 43 23 03. Condition E shall be located within the Preferred Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application. Pump shall be capable of operating at this condition without objectionable vibration or cavitation. Condition A represents this same scenario, only the pump in Condition A operates under the highest anticipated total head.*
6. *Condition F-1 and F-2 is the anticipated continuous duty minimum and maximum (respectively) speed condition when performing a forward flush at the end of a backwash cycle under the lowest and highest (respectively) anticipated total head. Pumps furnished under this specification shall be capable of sustained operation at this condition for a period of approximately one minute within the requirements set forth in Section 43 23 03. Condition F-1 shall be located within the Preferred Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application. Condition F-2 may operate within the Allowable Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application. Pump shall be capable of operating at both conditions without objectionable vibration or cavitation.*
7. *Total head in the above tabulation is the algebraic difference between the discharge head and suction head as defined in ANSI/HI 1.1 – 1.6. NPSHA in the above tabulation refers to the pump inlet piping at centerline elevation as shown and is calculated in accordance with ANSI/HI 1.3 for average barometric pressure and maximum temperature conditions. NPSHA at the pump impeller eye can be determined by adjusting the given value by proposed pump dimensions and the indicated requirements for pump installation details. Required NPSHA margin shall be as specified in Section 43 23 03.*

D. Design Requirements:

Item	Value
Equipment number	P2110, P2120
Pump	Raw Water Feed
Rigid sphere, inches diameter (min.), capable of pass through the pump from inlet to discharge	2
Minimum efficiency at best efficiency point (BEP) at maximum speed, percent[a]	65
Piping connection size, inches, minimum	
Pump inlet	4
Pump discharge	6
Operating speed, rpm, maximum	1800
Operating speed, constant or variable	Variable
Motor (See Section 43 05 21):	
Horsepower	40
Type (See Section 43 05 21)	TEFC – (Corrosion) Severe Duty, Enclosed Type 2
Inverter duty	Yes
Space heater	Yes
Thermal protection	Yes TSH
Temperature sensors	None
Ambient duty rating	+40, High Altitude
Operating speed, rpm, maximum	1800
Voltage rating	460 volt, 3 Phase

Item	Value
Equipment number	P2110, P2120
Motor starting type	VFD
Voltage rating	460 volt, 3 Phase

Note:

a. The minimum acceptable efficiency at BEP at the speed required to achieve the performance specified under Condition Points A and B. The minimum acceptable efficiency is not necessarily required to be associated with any operating condition specified in paragraph 2.03.B Operating Conditions.

E. Vibration and Critical Speeds:
   1. The pumps shall comply with the requirements of Section 43 23 03-1.04.

2.04 SYSTEM OPERATION

A. The pumps will be installed in a heated and ventilated dry well room at high elevation. One pump is a standby pump; the remainder are duty pumps. The pumps will be controlled by the central plant control system. Refer to Section 40 61 96.

2.05 MATERIALS

A. General:
   1. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials to provide greater strength or meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

B. Pumps:
   1. Pump materials shall be as follows:

Component	Material
Casing and nozzles	Ductile iron, ASTM A395, or cast iron, ASTM A48
Shaft	Steel, AISI 1045, or SAE 4140
Frame	Cast iron, ASTM A48
Impeller	Ductile iron, ASTM A536 or A 395, cast iron, ASTM A48, or cast steel ASTM A216

2.06 COMPONENTS

A. Casing and Backhead:
   1. The casing shall be foot mounted and provided with bosses for suction and discharge gage connections and casing drain.
   2. The back head shall permit removal of the impeller, shaft, and bearings without disturbing piping connections.
   3. The back head shall be provided with a “big bore” seal chamber to allow installation and ease of access to larger cartridge seals.

B. Impeller:
   1. The pump impeller shall be open or reverse vane, single-suction type, screwed to the shaft, and sealed with an O ring.
   2. Pump shall be provided with external adjustment of impeller clearance.

C. Shaft:
   1. The shaft, where inside the stuffing box, shall have no reduction in size as specified in paragraph 43 05 11-2.04 Shaft Packing.

D. Mechanical Seal:
   1. Single mechanical seals shall be provided as specified in paragraph 43 05 11-2.04 Mechanical Seals.
   2. Provide an API Plan 31 seal flushing system.

E. Bearing and Bearing Isolators:
   1. Bearings and bearing isolators shall be provided as specified in paragraphs 43 23 03-1.04 Bearing Isolators and Pump Shaft Seals.

F. Motors:
   1. Pumps shall be driven by motors conforming to the requirements of paragraph 2.03 Design Requirements, Section 43 23 03, and Section 43 05 21.

2.07 EQUIPMENT MOUNTS

A. Mounting Plates:
   1. Mounting plates shall be Baseplate per Section 43 05 13.
   2. Mounting plate shall be leveled to 0.002 inch/foot or less unless requirements from Manufacturer are more stringent.
   3. Pump and motor shall be mounted on a common baseplate.
   4. Baseplate shall collect, contain, and direct seal water leakage to a single outlet.

B. Grout Type:
   1. Use Epoxy Grout or Cementitious Non-Shrink Grout per Section 03 60 00.

C. Equipment Anchors:
   1. Install using details and instructions defined in the drawings.

D. Equipment Anchor Sleeves:
   1. Install per Section 43 05 13.
   2. Length shall not be less than 15D (D = nominal bolt diameter; bolt diameter determined by mounting plate manufacturer).

E. Equipment Pad:
   1. Install using details and instructions defined in the drawings.

2.08 FINISHES

A. Prime and finished coating shall be shop applied and shall be ANSI/NSF-61 certified material and compatible with abrasion from low levels of particulates.

2.09 SOURCE QUALITY CONTROL

A. Hydrostatic Tests:
   1. Factory test all pressure sustaining parts.
   2. Conform to the requirements of paragraph 8.3.2 of ANSI/ ANSI/API 610.
   3. Hold castings at the test pressure for 30 minutes for all pumps with discharge nozzles 14 inches in diameter and less, and 60 minutes for pumps with discharge nozzles 16 inches in diameter and greater.
   4. Certify correct and notarize by an officer of the pump manufacturer's corporation.

B. Performance Tests:
   1. Factory performance and NPSH tests will not be required. However, the manufacturer must be prepared to guarantee the performance specified under paragraph 43 23 89.11-2.03.

PART 3 EXECUTION

3.01 EQUIPMENT MOUNTING

A. Comply with procedures described in Section 43 05 13.

B. Position equipment pad and equipment anchors for final placement of equipment.

C. Use a bolting template to position equipment anchors.

D. Level mounting plates.

E. Pour grout bed supporting each mounting plate.

F. Eliminate grout voids below mounting plate.

G. Tension equipment anchors.

H. Provide a completed Form 43 05 13-A Section 01 99 90, for each equipment installation.

3.02 ALIGNMENT

A. Comply with procedures described in Section 43 05 14.

3.03 FIELD QUALITY CONTROL

A. Field Testing:
   1. Perform lateral vibration testing as specified in Section 43 23 03.

2. Include in the bid all costs for services of Testing Firms and Design Professionals performing these services.

B. Manufacturer Services:
   1. On-Site Inspections and Training
      a. Provide a factory-trained manufacturer's representative at the Site for the following activities. Specified durations do not include travel time to or from Site.
         1) Installation inspections
            a) Assist, supervise, and inspect the Contractor's activities during installation.
            b) Provide 8 inspection hours.
            c) Provide a completed Form 43 05 11-A, Section 01 99 90.
         2) Component test phase inspections
            a) Assist, supervise, and inspect the Contractor's activities during the system test phase specified in Section 01 45 20 and this Section.
            b) Provide 8inspection hours.
         3) System test phase inspections
            a) Assist, supervise, and inspect the Contractor's activities during the system test phase specified in Section 01 45 20.
            b) Provide 4 inspection hours.
         4) Operational test phase inspections
            a) Assist, supervise, and inspect the Contractor's activities during the operational test phase specified in Section 01 45 20.
            b) Provide 4 inspection hours.
         5) Training sessions
            a) Comply with procedures described in Section 01 79 00.
            b) Provide a minimum of 8 hours classroom training for each training session.
            c) Conduct two training sessions, one training session per week on two consecutive weeks to accommodate the shift schedules of operation and maintenance staff.
            d) Certify completion of training on Form 43 05 11-B, Section 01 99 90.
      b. Coordinate testing with requirements of Section 26 29 23.

3.04 SYSTEMS STARTUP

A. Comply with procedures described in Section 01 45 20.

B. Preoperational (factory) testing:
   1. See paragraphs 1.07 and 2.09

C. Component testing:
   1. Complete lateral vibration testing of all pumps in accordance with Section 43 23 03.

D. System testing:

1. If vibration testing reveals that operation is impaired by poor operation of ancillary equipment (sticking check valves, plugged air/vacuum reliefs, improperly torqued flanges, etc.), repair ancillaries and retest pumps if directed by the Owner.
2. After Owner/Engineer review of the Vibration Design Professional's draft and final reports for lateral and torsional vibration participate with the Owner and Engineer to make required adjustments to the pumping control strategy to avoid damaging vibrations, protect the pumps, and meet performance requirements.

END OF SECTION

SECTION 43 23 92.01

MULTI-STAGE VERTICAL CENTRIFUGAL PUMPS – VOLUME 1 INTAKE FACILITY

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies vertical multi-stage, variable speed, end suction, centrifugal pumps for Volume 1 Intake Stage 2 Grundfos Hydro-MPC E CRN185 4-4.

B. Intake PS Stage 2:
   1. Each pumping unit shall be complete with pump, drive unit, base, and all appurtenances to provide a complete pumping system.
   2. Except as specifically referenced in this section, Section 43 23 03 provisions will not apply to equipment furnished under this section.
   3. Stage 1 pumps and pump controller, refer to Section 42 23 71.

C. VFD:
   1. Provide per Section 26 29 23.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections not specifically listed below may apply.
   1. Section 26 29 23: Variable Frequency Motor Controllers.
   2. Section 43 05 11: General Requirements for Equipment.
   3. Section 43 05 17: Vibration and Critical Speed Limitations.
   4. Section 43 05 21: Common Motor Requirements for Equipment.

1.03 REFERENCES

A. References
   1. This section contains references to the following documents. These references are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. If requirements of this section conflict with those of the listed documents, requirements of this section prevail.
   2. Unless otherwise specified, reference documents refer to documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if no Bids). If referenced documents have been discontinued by the issuing organization, refer to replacement documents issued or otherwise identified by that organization. If there are no replacement documents, refer to the last version of the document before it was discontinued. Where document dates are given in the following listing, those documents refer to the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ABMA 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	Load Ratings and Fatigue Life for Roller Bearings
ASTMA A48	Gray Iron Castings
ASTM A108	Steel Bars, Carbon, Cold Finished, Standard Quality
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A278	Gray Iron Castings for Pressure Containing Parts for Temperatures of up to 650 Degrees F
ASTM A322	Steel Bars, Alloy, Standard Grades
ASTM A576	Steel Bars, Carbon, Hot Wrought, Special Quality
ASTM A743/A743M	Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion-Resistance for General Application
Hydraulic Institute Standards	Latest Standards of the Hydraulic Institute

1.04 DEFINITIONS

A. Terminology used in this section conforms to the following definitions:
   1. Equipment pad: concrete foundation (block or slab) supporting and elevating equipment mounts above the supporting structural floor slab or local grade.
   2. Mounting pads: thickened or raised areas of baseplates and soleplates where the feet or mounting surfaces of mounted equipment and drivers rest on the baseplate or soleplate.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Unit Responsibility
   1. Assign unit responsibility, as specified in Section 43 05 11, to the pump manufacturer for the pumps and motors as specified in this section and Section 43 05 21, and for the VFD specified in Section 26 29 23.
   2. Provide a completed and signed Unit Responsibility Certification Form (Form 43 05 11-C, Section 01 99 90).

1.06 SUBMITTALS

A. Action Submittals
   1. Comply with procedures described in Section 01 33 00.
   2. Shop Drawings:
      a. Submit a copy of this specification section (with addendum updates included) and all referenced and applicable sections (with addendum updates included).
         1) Mark each paragraph with a check-mark (✓) to indicate specification compliance or mark to indicate requested deviations from specification requirements.
         2) Use check-marks (✓) to denote full compliance with a paragraph as a whole.
         3) If deviations from the specifications are indicated, underline and denote each deviation with a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations.

4) Remaining portions of the paragraph not underlined signify the Contractor's compliance with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

b. Submit a copy of the contract document Electrical Drawings E-102, E-103, E-104, and E-109, and Mechanical Drawings C-007 and C-008 relating to the submitted equipment. Include addendum updates applying to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, mark the drawing or drawings with *"no changes required"*. Failure to include copies of relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

c. Show predicted pump performance curves. Show head, capacity, speed, power, efficiency, and net positive suction head (NPSH) required on the ordinate plotted against capacity on the abscissa.

d. Provide motor submittal information as specified in Section 43 05 21.

e. Provide drawings showing general dimensions and confirming pump piping connections, with construction details including dimensions and materials of construction, and wiring diagrams.

f. Provide manufacturer's catalog data, showing materials of construction and including a list of spare parts to be provided.

g. Submit VFD per requirements of Section 26 29 23. May be submitted separately.

3. Variable Frequency Drives:
   a. Refer to Section 26 29 23.
   b. Submit with pump shop drawings, or submit separately.

B. Informational Submittals
   1. Comply with procedures described in Section 01 33 00:
      a. Show guaranteed pump performance curves.
      b. Provide certification that pumping units meet vibration and critical speed limitations as specified in Section 43 05 17.
      c. Submit Installation Certification Form 43 05 11-A as specified in paragraph 43 23 92-3.01.
      d. Submit Training Certification Form 43 05 11-B as specified in paragraph 43 23 92-3.02.
      e. Refer to Section 42 23 71 for system testing certification.

C. Closeout Submittals
   1. Comply with procedures described in Section 01 78 23.
      a. Provide field vibration test reports in accordance with paragraph 43 23 03-3.06.
      b. Provide operating and maintenance submittals as specified in Section 01 78 23.
         1) Include copy of final reviewed shop drawing submittal.

c. Spare Parts

1) The following spare parts shall be provided if one pump is furnished under this section. If more than one pump is furnished, the following shall be provided for each pair of pumps. Spare parts shall be tagged and stored as specified in paragraph 43 05 11-2.12.

a) Three sets of all gaskets

b) One set of pump bearings

c) One set of wearing rings

d) One set of seals, including shaft seal

1.07 QUALITY ASSURANCE

A. Certifications

1. Manufacturers proposing to furnish equipment specified under this section shall hold current certification under ISO 9001-2001.
2. Application for certification under ISO 9001 is not an acceptable substitute for current certification. Documentation attesting to current certification shall be signed by an officer of the manufacturer's corporation and notarized.

B. Critical Speeds

1. Critical speeds shall be in accordance with Section 43 23 03-1.04 except when the title of the detailed section includes "Custom Engineered" in which case Section 43 23 03-1.05 applies.

C. Vibration Limits

1. Vibration limits shall be in accordance with Section 43 23 03-3.06 and subject to field testing in accordance with paragraph 3.04 of this section.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following manufacturer is capable of producing equipment and/or products satisfying the requirements of this section. Manufacturers and models shall be as specified for the purpose of compatible and efficient utilization of existing equipment, supplies, and personnel training and experience, no substitutions are permitted.

1. Grundfos.

2.02 VARIABLE SPEED PACKAGED PUMPING SYSTEM

A. Furnish and install a pre-fabricated and tested variable speed packaged pumping system to maintain the specified water delivery flowrate and pressure and able to perform the "stage 2 pump" function described in Section 40 61 96 Process Control Description.

B. The packaged pump system shall be a standard product of a single pump manufacturer. The entire pump system including pumps and pump controller, shall be designed, built, and tested by the same manufacturer.

C. The complete packaged water booster pump system shall be certified and listed by UL (Category QCZJ – Packaged Pumping Systems) for conformance to U.S. and Canadian Standards.

D. The complete packaged pumping system shall be NSF61 / NSF372 Listed for drinking water and low lead requirements.

E. The packaged pump system shall be ASHRAE 90.1 – 2010 compliant without the need of a remote mounted sensor. The control logic used to simulate a remote mounted sensor shall be proportional pressure control with squared or linear adaptation. An actual flow rate or calculated flow rate based on performance curves (5th order polynomial) loaded into the controller; shall be used to adjust setpoint pressure in proportional pressure control.

F. Refer also to Section 42 23 71.

2.03 PUMPS

A. All pumps shall be ANSI NSF 61 / NSF372 Listed for drinking water and low lead requirements.

B. The pumps shall be of the in-line vertical multi-stage design.

C. The head-capacity curve shall have a steady rise in head from maximum to minimum flow within the preferred operating region. The shut-off head shall be a minimum of 20% higher than the head at the best efficiency point.

D. The pumps shall be Grundfos CR185 In-line Vertical Multi-Stage Pumps and shall have the following features:

1. The pump impellers shall be secured directly to the smooth pump shaft by means of a split cone and nut design.
2. The suction/discharge base shall have ANSI Class 150/300, respectively, flange connections in a slip ring (rotating flange) design as indicated in the drawings or pump schedule. See Pump Drawing Plan Sheet C-007.
3. Pump Construction
   a. Suction/discharge base, pump head: 316 Stainless Steel (ASTM CF-8M)
   b. Shaft couplings, flange rings: Ductile Iron (ASTM 70-50-05)
   c. Shaft: 431 Stainless Steel
   d. Motor Stool: Cast Iron (ASTM Class 30)
   e. Impellers, diffuser chambers, outer sleeve: 304 Stainless Steel
   f. Impeller wear rings: 304 Stainless Steel
   g. Intermediate Bearing Journals: Silicon Carbide
   h. Intermediate Chamber Bearings: Leadless Tin Bronze
   i. Chamber Bushings: Graphite Filled PTFE
   j. O-rings: EPDM
   k. All wetted parts shall be stainless steel.

E. The shaft seal shall be a balanced O-ring cartridge type with the following features:
   a. Collar, Drivers, Spring: 316 Stainless Steel
   b. Shaft Sleeve, Gland Plate: 316 Stainless Steel
   c. Stationary Ring: Graphite embedded Silicon Carbide
   d. Rotating Ring: Graphite embedded Silicon Carbide
   e. O-rings: EPDM
   f. Shaft seal replacement shall be possible without removal of any pump components other than the coupling guard, motor couplings, motor and seal cover. The entire cartridge shaft seal shall be removable as a one-piece component.

F. Pumps shall have adequate space within the motor stool so that shaft seal replacement is possible without motor removal.

G. The head-capacity curves of these stage 2 pumps shall have a continuously rising head characteristic with decreasing capacity and shall match the curves provided in the drawings. The new pumps shall each have the following primary operating characteristics, which shall be considered the rated, continuous-duty operating condition. These stage 2 pumps must perform satisfactorily in series with the stage 1 pumps to achieve the project objectives.
   a. Capacity = 700 gpm
   b. Total dynamic head = 618 ft

2.04 PUMP CONTROLLER

A. Refer to Section 42 23 71.

2.05 PERFORMANCE/DESIGN CRITERIA

A. Service Conditions
   1. The pump shall be designed to pump 700 gpm @ TDH of 618 ft. See Pump performance curves Plan Sheets C-007.
   2. The fluid to be pumped is raw water anticipated to range between 40 degrees F and 70 degrees F and may be expected to contain small particles of sand, grit and organic particals.
   3. The pumps will be operated at constant speed with variable speed start and stop ramping.

B. Operating Conditions
   1. The pump shall perform in accordance with the following:

Full Speed Operation	Grundfos Hydro MPC E CRN185-4-4
Condition (Guaranteed Performance):	
Capacity, gpm	700
Total head, feet	618
Net positive suction head available (NPSHA), psi	15.0 at Stage 2 intake manifold

2. The pump shall be designed to operate without damaging cavitation, and the motor and pump combination shall operate without vibration over the specified range of conditions. The pump head capacity curve shall slope in one continuous curve with no point of reverse slope inflection.
3. All components shall be designed to safely withstand forces resulting from flow reversals, up to 125 percent of maximum speed, within the pump during shutdowns caused by power failure.
4. The complete pumping unit shall be designed to operate without overload on any component at any point along the pump's entire operating curve without using the motor's service factor.
5. Equipment motors furnished under this section shall conform to the following characteristics:

Motor	
Horsepower	150
Type (See Section 43 05 21)	Totally Enclosed Fan Cooled (TEFC)
Inverter duty	Yes
Space heater	No
Thermal protection	Yes, thermostat
Ambient duty rating	+40, Elev. Approx. 4,000'
Voltage rating	460 volt, 3 Phase

C. Vibration and Critical Speeds
   1. The pump shall comply with the requirements of Section 43 05 17.

2.06 SYSTEM CONSTRUCTION / MATERIALS

A. Materials of construction shall be as follows:
   1. Suction and discharge manifold construction shall be in way that ensures minimal pressure drops, minimize potential for corrosion, and prevents bacteria growth at intersection of piping into the manifold. Manifold construction that includes sharp edge transitions or interconnecting piping protruding into manifold is not acceptable. Manifold construction shall be such that water stagnation cannot exist in manifold during operation to prevent bacteria growth inside manifold.
   2. The suction and discharge manifolds material shall be 316 stainless steel. Manifold connection sizes shall be as follows:
      a. 10 inch and larger: ANSI Class 150 flanges (suction) and Class 300 (discharge)
   3. Pump Isolation valves shall be provided on the suction and discharge of each pump. Isolation valve sizes 2 inch and smaller shall be nickel plated brass full port ball valves. Isolation valve sizes 3 inch and larger shall be a full lug style butterfly valve. The valve disk shall be of stainless steel. The valve seat material shall be EPDM and the body shall be cast iron, coated internally and externally with fusion-bonded epoxy.

4. A spring-loaded non-slam type check valve shall be installed on the discharge of each pump. The valve shall be a wafer style type fitted between two flanges. The head loss through the check valve shall not exceed 5 psi at the pump design capacity. Check valves 1-1/2" and smaller shall have a POM composite body and poppet, a stainless steel spring with EPDM or NBR seats. Check valves 2" and larger shall have a body material of stainless steel or epoxy coated iron (fusion bonded) with an EPDM or NBR resilient seat. Spring material shall be stainless steel. Disk shall be of stainless steel or leadless bronze.
5. A pressure transducer shall be factory installed on the discharge manifold (or field installed as specified on plans). Systems with positive inlet gauge pressure shall have a factory installed pressure transducer on the suction manifold for water shortage protection. Pressure transducers shall be made of 316 stainless steel. Transducer accuracy shall be +/- 1.0% full scale with hysteresis and repeatability of no greater than 0.1% full scale. The output signal shall be 4-20 mA with a supply voltage range of 9-32 VDC.
6. A bourdon tube pressure gauge, 2.5 inch diameter, shall be placed on the suction and discharge manifolds. The gauge shall be liquid filled and have copper alloy internal parts in a stainless steel case. Gauge accuracy shall be 2/1/2 %. The gauge shall be capable of a pressure of 30% above its maximum span without requiring recalibration.
7. Systems with a flooded suction inlet or suction lift configuration shall have a factory installed water shortage protection device on the suction manifold.
8. The pump system base shall be powder coated white aluminum RAL9006, carbon steel ASTM A36 structural steel.
9. Rubber vibration dampeners shall be fitted between each pumps and base frame to minimize vibration.

2.07 EQUIPMENT MOUNTS

A. Mounting Plates
   1. Use Fabricated Steel Frame.
   2. Install mounting plates per Section 43 05 13.
   3. Mount plate leveled.
   4. Mount pump and motor on a common baseplate. Baseplate collects, contains, and directs seal water leakage to a single outlet.

B. Grout Type
   1. Use Epoxy Grout per Section 03 60 00.

C. Equipment Anchors
   1. Install per Mechanical Drawing C-005.

D. Equipment Anchor Sleeves
   1. Install per Section 43 05 13.
   2. Length shall be as shown on Mechanical Drawing C-005.

E. Equipment Pad
   1. Install per Mechanical Drawing C-005.

2.08 SOURCE QUALITY CONTROL

A. Factory Tests
   1. The tester used for testing the pump system shall be constructed and calibrated according to the requirements of hydraulic test standard ISO 9906.
   2. B. The entire pump station shall as a minimum be factory tested for functionality and documented results of functionality test supplied with pump station.
   3. Functionality testing shall include the following parameters:
      a. Complete System Hydrostatic Test – 1.5 times the nameplate maximum pressure
      b. No-Flow Detection Shutoff Test
      c. Water Shortage Test
      d. Two-Point Setpoint Performance Test.
   4. Water used for testing shall be treated with three different filtration systems to ensure only clean water is used for testing pump station.
      a. 25 micron mechanical filter – removes solid parts from water
      b. Activated carbon filter – keeps water clear and eliminates odor
      c. Ultraviolet light system – kills all bacteria growth
   5. Performance testing shall include:
      a. 10-Point Verified Performance Test

PART 3 EXECUTION

3.01 INSTALLATION

A. Each pumping unit shall be aligned, connected, and installed in accordance with the manufacturer's recommendations.

B. The installation shall be certified on Form 43 05 11-A as specified in Section 01 99 90.

3.02 FIELD QUALITY CONTROL

A. After completion of installation, each pumping unit shall be field tested to demonstrate compliance with the performance requirements as specified.

B. Training:
   1. A minimum of 2 hours of training shall be provided by the pump manufacturer’s service representative.
   2. Training shall conform to Section 01 79 00.
   3. Certify completion of training on Form 43 05 11-B as specified in Section 01 99 90.

C. Manufacturer Services, coordinate with Section 42 23 71:
   1. Installation Inspection: Assist, supervise, and inspect the Contractor’s activities during installation. Provide 6 hours onsite for each pump.
   2. Assist the Contractor in preparing test procedures as specified in Section 01 45 20.
   3. Component Test Phase Inspections: Assist, supervise, and inspect the Contractor’s activities during the system test phase specified in Section 01 45 20 and this Section. Provide 6 hours onsite for each component.

4. System Test Phase Inspections: Assist, supervise, and inspect the Contractor's activities during the system test phase specified in Section 01 45 20. Provide 24 hours onsite.
5. Operational Test Phase Inspections: Assist, supervise, and inspect the Contractor's activities during the operational test phase specified in Section 01 45 20. Provide 16 hours onsite.

END OF SECTION

SECTION 43 23 92.02

MULTI-STAGE VERTICAL CENTRIFUGAL PUMPS – VOLUME 2 WTP

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies vertical multi-stage, constant speed, end suction, centrifugal pumps for the LeChee Water Treatment Plant.
   1. Each pumping unit shall be complete with pump, drive unit, base, and all appurtenances to provide a complete pumping system.
   2. Except as specifically referenced in this section, Section 43 23 03 provisions will not apply to equipment furnished under this section.

B. Equipment List

Item	Equipment Number
Membrane Backwash Pump 1	P2241
Membrane Backwash Pump 2	P2242
Clean-in-Place Pump 1	P2251
Clean-in-Place Pump 2	P2252
GAC Backwash Pump	P2300
Chlorine Booster Pump 1	P2421
Chlorine Booster Pump 2	P2422
Chlorine Booster Pump 3	P2423

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections not specifically listed below may apply.
   1. Section 26 29 23: Variable Frequency Motor Controllers
   2. Section 43 05 11: General Requirements for Equipment
   3. Section 43 05 17: Vibration and Critical Speed Limitations
   4. Section 43 05 21: Common Motor Requirements for Equipment

1.03 REFERENCES

A. References
   1. This section contains references to the following documents. These references are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. If requirements of this section conflict with those of the listed documents, requirements of this section prevail.
   2. Unless otherwise specified, reference documents refer to documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if no Bids). If referenced documents have been discontinued by the issuing organization, refer to replacement documents issued or otherwise identified by that organization. If there are no replacement documents, refer to the last version of the document before it was discontinued. Where document dates are given in the

following listing, those documents refer to the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ABMA 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	Load Ratings and Fatigue Life for Roller Bearings
ASTMA A48	Gray Iron Castings
ASTM A108	Steel Bars, Carbon, Cold Finished, Standard Quality
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A278	Gray Iron Castings for Pressure Containing Parts for Temperatures of up to 650 Degrees F
ASTM A322	Steel Bars, Alloy, Standard Grades
ASTM A576	Steel Bars, Carbon, Hot Wrought, Special Quality
ASTM A743/A743M	Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion-Resistance for General Application
Hydraulic Institute Standards	Latest Standards of the Hydraulic Institute

1.04 DEFINITIONS

A. Terminology used in this section conforms to the following definitions:
   1. Equipment pad: concrete foundation (block or slab) supporting and elevating equipment mounts above the supporting structural floor slab or local grade.
   2. Mounting pads: thickened or raised areas of baseplates and soleplates where the feet or mounting surfaces of mounted equipment and drivers rest on the baseplate or soleplate.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Unit Responsibility:
   1. Assign unit responsibility, as specified in Section 43 05 11, to the pump manufacturer for the pumps and motors as specified in this section and Section 43 05 21 (unless provided as a part of an equipment package), and for the VFDs specified in Section 26 29 23. Provide a completed and signed Unit Responsibility Certification Form (Form 43 05 11-C, Section 01 99 90). Unit responsibility shall be assigned to the manufacturer of the equipment package (i.e. the manufacturer of the equipment package provided for 46 61 33) for all pumps provided as part of an equipment package.

1.06 SUBMITTALS

A. Action Submittals – Shop Drawings:
   1. Comply with procedures described in Section 01 33 00:
   2. Submit a copy of this specification section (with addendum updates included) and all referenced and applicable sections (with addendum updates included).
      a. Mark each paragraph with a check-mark (✓) to indicate specification compliance or mark to indicate requested deviations from specification requirements.
      b. Use check-marks (✓) to denote full compliance with a paragraph as a whole.

c. If deviations from the specifications are indicated, underline and denote each deviation with a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations.

d. Remaining portions of the paragraph not underlined signify the Contractor's compliance with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Completed Certificate of Unit Responsibility attesting that the Contractor has assigned, and that the manufacturer accepts unit responsibility in accordance with the requirements of this Section and Section 43 05 11-1.02. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.
4. Submit a copy of the contract document control diagrams E-00-524 and process and instrumentation diagrams I-22-108, 109, and I-23-101 relating to the submitted equipment. Include addendum updates applying to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, mark the drawing or drawings with *"no changes required"*. Failure to include copies of relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
5. Show predicted pump performance curves. Show head, capacity, speed, power, efficiency, and net positive suction head (NPSH) required on the ordinate plotted against capacity on the abscissa.
6. Provide certification that pumping units meet vibration and critical speed limitations as specified in Section 43 05 17.
7. Provide motor submittal information as specified in Section 43 05 21.
8. Provide drawings showing general dimensions and confirming pump piping connections, with construction details including dimensions and materials of construction, and wiring diagrams.
9. Provide manufacturer's catalog data, showing materials of construction.
10. Include a list of spare parts to be provided.

B. Informational Submittals

1. Comply with procedures described in Section 01 33 00:
   a. Show guaranteed pump performance curves.
   b. Provide applicable operation and maintenance information as specified in Section 01 78 23.
   c. Submit Installation Certification Form 43 05 11-A as specified in paragraph 3.01.
   d. Provide motor product data as specified in paragraph 43 05 21-2.05.
   e. Submit Training Certification Form 43 05 11-B as specified in paragraph 3.03.

C. Closeout Submittals

1. Comply with procedures described in Section 01 78 23.
   a. Provide field vibration test reports in accordance with paragraph 3.06.

b. Provide operating and maintenance submittals as specified in Section 01 78 23. Include final reviewed shop drawing submittal.

c. Spare Parts

1) The following spare parts shall be provided if one pump is furnished under this section. If more than one pump is furnished, the following shall be provided for each pair of pumps. Spare parts shall be tagged and stored as specified in paragraph 43 05 11-2.12.

a) Three sets of all gaskets

b) One set of pump bearings

c) One set of wearing rings

d) One set of seals, including shaft seal

1.07 QUALITY ASSURANCE

A. Certifications

1. Manufacturers proposing to furnish equipment specified under this section shall hold current certification under ISO 9001-2001.
2. Application for certification under ISO 9001 is not an acceptable substitute for current certification. Documentation attesting to current certification shall be signed by an officer of the manufacturer's corporation and notarized.

B. Critical Speeds

1. Critical speeds shall be in accordance with Section 43 23 03-1.04.

C. Vibration Limits

1. Vibration limits shall be in accordance with Section 43 23 03-3.05 and subject to field testing in accordance with paragraph 3.04 of this section.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following candidate manufacturers are capable of producing equipment and/or products satisfying the requirements of this section. The manufacturer's standard product may require modification to conform to specified requirements.

1. Grundfos
2. Aurora
3. Taco
4. Approved equal

2.02 PERFORMANCE/DESIGN CRITERIA

A. Service Conditions

1. The pump shall be designed to pump Membrane Backwash Water, Chemical Solution, GAC Backwash. Chlorine Solution

2. The fluid to be pumped is anticipated to range between 36 degrees F and 80 degrees F and may be expected to contain small traces of fine sediment and in the case of the Clean-In-Place (CIP) Pumps, diluted concentrations of Citric Acid, Sodium Bisulfite, Sodium Hydroxide, Sodium Hypochlorite, and Sulfuric Acid
3. The Membrane Backwash, CIP, and GAC pumps will be operated at variable speed. The Chlorine Booster Pumps will be operated at a constant speed.

B. Operating Conditions

1. The pump shall perform in accordance with the following:

Equipment Numbers	P2241 P2242	P2251 P2252	P2300	P2421 P2422 P2423
Full Speed Operation				
Condition A [a,d] (Guaranteed Performance):				
Capacity, gpm	440	250	650	4.4
Total head, feet	115	87	115	85
Net positive suction head available (NPSHA), feet	29	29	35	24
Condition B [b,d] (Minimum Operating Head):				
Capacity, gpm	H/Q Curve	H/Q Curve	H/Q Curve	H/Q Curve
Total head, feet	109	79	110	80
NPSHA, feet	34	37	60.4	22
Reduced Speed Operation				
Condition C [c,d] (Guaranteed Performance):				
Capacity, gpm	400	250	450	N/A
Total head, feet	80	40	55	N/A
Pump Speed, Reduced rpm	2900	2700	2400	N/A
NPSHA, feet	29	29	35	N/A

Notes:

a. Condition A shall be taken as the rated, continuous-duty operating condition. Performance at the rated condition shall be guaranteed in accordance with Section 43 23 03. Condition A has been selected to obtain the rated pumping capacity for the installation. It is not intended that the pumps be selected for maximum efficiency at Condition A. Pumps furnished under this section shall be selected to achieve Condition A performance, and shall operate continuously without objectionable vibration or cavitation at the head specified under Condition B. Condition A may be located in the Allowable Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and published in the manufacturer's published application data for the specific model proposed for this application.

b. Condition B head is presented to indicate operating conditions when the pump is operating against minimum anticipated system head, assuming a hypothetical head-capacity curve. Condition B shall be used for pump selection. Condition B shall be located within the Preferred Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application. Condition B shall be located to the right of the best efficiency point flow rate (BEPQ) and not less than 110 percent of BEPQ. Pumps with head-capacity curves steeper than that assumed will produce somewhat less flow at somewhat lower head. The reverse will occur with pumps having a shallower head-capacity curve. NPSHA, as listed for Condition B is calculated on a pumped flow of 475.0 gpm for P2241 and P22442, 300.0 gpm for P2251 and P2252, 700.0 gpm for P2300, and 5.0 gpm for P2421, P2422 and P2423.

c. Condition C is the anticipated continuous duty minimum speed condition. Select pumps furnished under this specification that are capable of sustained (24 hours per day) operation at this condition within the requirements set forth in Section 43 23 03. Condition C shall be located within the Preferred Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application.

d. Total head in the above tabulation is the algebraic difference between the discharge head and suction head as defined in ANSI/HI 1.1–1.6. net positive suction head available (NPSHA) in the above tabulation is referred to the pump inlet piping at centerline elevation as shown and is calculated in accordance with ANSI/HI 1.3 for average barometric pressure and maximum temperature conditions. NPSHA at the pump impeller eye can be determined by adjusting the given value by proposed pump dimensions and the indicated requirements for pump installation details. An allowance of 5 feet has been included for the presence of volatile constituents in the pumped fluid. Required NPSHA margin shall be as specified in Section 43 23 03.

C. Design Requirements

1. The pump shall be designed to operate without damaging cavitation, and the motor and pump combination shall operate without vibration over the specified range of conditions. The pump head capacity curve shall slope in one continuous curve with no point of reverse slope inflection.
2. All components shall be designed to safely withstand forces resulting from flow reversals, up to 125 percent of maximum speed, within the pump during shutdowns caused by power failure.
3. The complete pumping unit shall be designed to operate without overload on any component at any point along the pump's entire operating curve without using the motor's service factor.
4. Equipment furnished under this section shall conform to the following characteristics:

Equipment Numbers	P2241 P2242	P2251 P2252	P2300	P2421 P2422 P2423
Pump				
Efficiency at Condition A, minimum, percent	60	60	60	34
Piping connection size, inches				
Inlet	4	3	6	1
Discharge	4	3	6	1
Motor				
Horsepower	20	15	30	0.33
Type (See Section 43 05 21)	Type 2	Type 2	Type 2	Type 2
Inverter duty	Yes	Yes	Yes	No
Space heater	No	No	No	No
Thermal protection	Yes	Yes	Yes	Yes
Ambient duty rating	+40	+40	+40	+40
Voltage rating	460 volt 3 Phase	460 volt 3 Phase	460 volt 3 Phase	460 volt 3 Phase
Scope	Membrane Manufacturer	Membrane Manufacturer	Contractor	Contractor

Notes:

a. The motor shall be nonoverloading within the selection criteria set forth in Section 43 05 21. Pump selections which do not conform to this requirement without requiring a motor with a nameplate rating greater than that listed are not acceptable.

D. Vibration and Critical Speeds

1. The pump shall comply with the requirements of Section 43 05 17.

2.03 MATERIALS

A. Materials of construction shall be as follows:

Component	Material
Suction/discharge base, pump head, flanges and couplings	316 Stainless Steel)
Motor stool	Cast iron
Shaft	Stainless steel, Type 316
Impellers 1	Stainless steel, Type 316
Wearing rings	Teflon or Equal
Intermediate bearings	Graflon or Equal
Bottom bearing rings, shaft journal	Tungsten carbide, replaceable
Cartridge shaft seal	Per manufacturer, corrosion resistant, replaceable without disassembling pump (EPDM [std], Viton, or Buna O-rings)
Motor seal	Per manufacturer, replaceable without removing motor

Notes:

a. Impellers shall be balanced at the factory. Balancing of the impeller in the field is not permitted.

b. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials to provide greater strength or meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

B. Variable Frequency Drive:
   1. The variable frequency drive shall conform to the requirements of Section 26 29 23.

2.04 EQUIPMENT MOUNTS

A. Mounting Plates
   1. Use Soleplate
   2. Install mounting plates per Section 43 05 13.
   3. Mount plate leveled to 0.002 inch/foot or less.
   4. Mount pump and motor on a common baseplate. Baseplate collects, contains, and directs seal water leakage to a single outlet.

B. Grout Type
   1. Use Epoxy Grout or Cementitious Non-Shrink Grout per Section 03 60 00.

C. Equipment Anchors
   1. Install as defined on drawings.

D. Equipment Anchor Sleeves
   1. Install per Section 43 05 13.
   2. Length shall not be less than 15D (D = nominal bolt diameter; bolt diameter determined by mounting plate manufacturer).

E. Equipment Pad
   1. Install as defined on drawings.

2.05 SOURCE QUALITY CONTROL

A. Factory Tests
   1. Factory tests are not be required. However, the manufacturer shall guarantee the performance specified under paragraph 2.02 Operating Conditions, Condition A.

PART 3 EXECUTION

3.01 INSTALLATION

A. Each pumping unit shall be aligned, connected, and installed in accordance with the manufacturer's recommendations.

B. The installation shall be certified on Form 43 05 11-A as specified in Section 01 99 90.

3.02 FIELD QUALITY CONTROL

A. After completion of installation, each pumping unit shall be field tested to demonstrate compliance with the performance requirements as specified.
   1. A minimum of 4 hours of training shall be provided by the pump manufacturer's service representative.
   2. Training shall conform to Section 01 79 00.
   3. Certify completion of training on Form 43 05 11-B as specified in Section 01 99 90.

END OF SECTION

SECTION 43 23 92.03

MULTI-STAGE VERTICAL CENTRIFUGAL PUMPS – VOLUME 3 PUMP STATION NO. 3

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies vertical multi-stage, variable speed, end suction, centrifugal pumps for the Volume 3 - LeChee Pump Station No. 3 Grundfos Boosterpaq CR 64-5-2 A-G-A-E-HQQE.

1. Each pumping unit shall be complete with pump, drive unit, base, variable frequency drive (VFD) control panel, and all appurtenances to provide a complete pumping system.
2. Except as specifically referenced in this section, Section 43 23 03 provisions will not apply to equipment furnished under this section.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections not specifically listed below may apply.

1. Section 43 05 11: General Requirements for Equipment.
2. Section 43 05 17: Vibration and Critical Speed Limitations.

1.03 REFERENCES

A. References

1. This section contains references to the following documents. These references are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. If requirements of this section conflict with those of the listed documents, requirements of this section prevail.
2. Unless otherwise specified, reference documents refer to documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if no Bids). If referenced documents have been discontinued by the issuing organization, refer to replacement documents issued or otherwise identified by that organization. If there are no replacement documents, refer to the last version of the document before it was discontinued. Where document dates are given in the following listing, those documents refer to the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ABMA 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	Load Ratings and Fatigue Life for Roller Bearings
ASTMA A48	Gray Iron Castings
ASTM A108	Steel Bars, Carbon, Cold Finished, Standard Quality
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A278	Gray Iron Castings for Pressure Containing Parts for Temperatures of up to 650 Degrees F
ASTM A322	Steel Bars, Alloy, Standard Grades

Reference	Title
ASTM A576	Steel Bars, Carbon, Hot Wrought, Special Quality
ASTM A743/A743M	Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion-Resistance for General Application
Hydraulic Institute Standards	Latest Standards of the Hydraulic Institute

1.04 DEFINITIONS

A. Terminology used in this section conforms to the following definitions:
   1. Equipment pad: concrete foundation (block or slab) supporting and elevating equipment mounts above the supporting structural floor slab or local grade.
   2. Mounting pads: thickened or raised areas of baseplates and soleplates where the feet or mounting surfaces of mounted equipment and drivers rest on the baseplate or soleplate.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Unit Responsibility
   1. Assign unit responsibility, as specified in Section 43 05 11, to the pump manufacturer for the pumps, motors, and VFD control panel as specified in this section.
   2. Provide a completed and signed Unit Responsibility Certification Form (Form 43 05 11-C, Section 01 99 90).

1.06 SUBMITTALS

A. Action Submittals
   1. Comply with procedures described in Section 01 33 00.
   2. Action Submittal - Shop Drawings:
      a. Submit a copy of this specification section (with addendum updates included) and all referenced and applicable sections (with addendum updates included).
         1) Mark each paragraph with a check-mark (✓) to indicate specification compliance or mark to indicate requested deviations from specification requirements.
         2) Use check-marks (✓) to denote full compliance with a paragraph as a whole.
         3) If deviations from the specifications are indicated, underline and denote each deviation with a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations.
         4) Remaining portions of the paragraph not underlined signify the Contractor's compliance with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

b. Submit a copy of the contract document Drawings E-101, E-102, M-100, and M-101 relating to the submitted equipment. Include addendum updates applying to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, mark the drawing or drawings with *"no changes required"*. Failure to include copies of relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

c. Show predicted pump performance curves. Show head, capacity, speed, power, efficiency, and net positive suction head (NPSH) required on the ordinate plotted against capacity on the abscissa.

d. Provide drawings showing general dimensions and confirming pump piping connections, with construction details including dimensions and materials of construction, and wiring diagrams.

e. Provide manufacturer's catalog data, showing materials of construction and including a list of spare parts to be provided.

f. Show guaranteed pump performance curves.

g. Provide certification that pumping units meet vibration and critical speed limitations as specified in Section 43 05 17.

3. Action Submittal - Control Panel (may be combined with Shop Drawings):

   a. Submit a copy of this specification section (with addendum updates included) and all referenced and applicable sections (with addendum updates included).

      1) Mark each paragraph with a check-mark (✓) to indicate specification compliance or mark to indicate requested deviations from specification requirements.

      2) Use check-marks (✓) to denote full compliance with a paragraph as a whole.

      3) If deviations from the specifications are indicated, underline and denote each deviation with a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations.

      4) Remaining portions of the paragraph not underlined signify the Contractor's compliance with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

   b. Submit a copy of the contract document Drawings E-101 and E-102 relating to the submitted equipment. Include addendum updates applying to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, mark the drawing or drawings with *"no changes required"*. Failure to include copies of relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

c. Submit a copy of the contract document NTUA Technical Provisions 4.0 PLC Control Panel (Booster with BoosterPAQ) drawings relating to the submitted equipment. Include addendum updates applying to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, mark the drawing or drawings with *"no changes required"*. Failure to include copies of relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

d. Catalog cuts of equipment, devices, and materials for products to be provided. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.

e. Control panel drawings:

1) Cover sheet with site name.

2) Bill of materials.

3) Schematic diagram.

4) Arrangement, layout, or outline.

5) External connections.

B. Informational Submittals

1. Comply with procedures described in Section 01 33 00:

a.

b. Submit Installation Certification Form 43 05 11-A as specified in paragraph 43 23 92-3.01.

c. Submit Training Certification Form 43 05 11-B as specified in paragraph 43 23 92-3.03.

C. Closeout Submittals

1. Comply with procedures described in Section 01 78 23.

a. Provide field vibration test reports in accordance with paragraph 43 23 03-3.06.

b. Provide operating and maintenance submittals as specified in Section 01 78 23, including final reviewed submittal and as-built drawings.

c. Spare Parts

1) The following spare parts shall be provided if one pump is furnished under this section. If more than one pump is furnished, the following shall be provided for each pair of pumps. Spare parts shall be tagged and stored as specified in paragraph 43 05 11-2.12.

a) 1-ea Pump Stack Kit

b) 1-ea O-ring/gasket kit

c) 1-ea Cartridge seal kit

1.07 QUALITY ASSURANCE

A. Certifications

1. Manufacturers proposing to furnish equipment specified under this section shall hold current certification under ISO 9001-2001.

2. Application for certification under ISO 9001 is not an acceptable substitute for current certification. Documentation attesting to current certification shall be signed by an officer of the manufacturer's corporation and notarized.

B. Critical Speeds
   1. Critical speeds shall be in accordance with Section 43 23 03-1.04 except when the title of the detailed section includes "Custom Engineered" in which case Section 43 23 03-1.05 applies.

C. Vibration Limits
   1. Vibration limits shall be in accordance with Section 43 23 03-3.06 and subject to field testing in accordance with paragraph 3.04 of this section.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following manufacturer is capable of producing equipment and/or products satisfying the requirements of this section. Manufacturers and models shall be as specified for the purpose of compatible and efficient utilization of existing equipment, supplies, and personnel training and experience, no substitutions are permitted.
   1. Grundfos.

2.02 PERFORMANCE/DESIGN CRITERIA

A. Service Conditions
   1. The pump shall be designed to pump potable water.
   2. The fluid to be pumped is anticipated to range between 40 degrees F and 68 degrees F.
   3. The pumps will normally be operated at a constant speed but have the ability to operate at variable speeds.

B. Operating Conditions
   1. The pump shall perform in accordance with the following:

Full Speed Operation	Equipment Number
Condition A [a,d] (Guaranteed Performance):	
Capacity, gpm	600
Total head, feet	485.4
Net positive suction head available (NPSHA), feet	173

C. Design Requirements
   1. The pump shall be designed to operate without damaging cavitation, and the motor and pump combination shall operate without vibration over the specified range of conditions. The pump head capacity curve shall slope in one continuous curve with no point of reverse slope inflection.
   2. All components shall be designed to safely withstand forces resulting from flow reversals, up to 125 percent of maximum speed, within the pump during shutdowns caused by power failure.

3. The complete pumping unit shall be designed to operate without overload on any component at any point along the pump's entire operating curve without using the motor's service factor.
4. Equipment furnished under this section shall conform to the following characteristics:

Pump	Equipment No.
Efficiency at Condition A, minimum, percent [a]	78
Piping connection size, inches, minimum	8
Inlet	8 ANSI 150
Discharge	8 ANSI 300
Motor	
Horsepower	60
Type	Totally Enclosed Fan Cooled (TEFC)
Inverter duty	Yes
Space heater	No
Thermal protection	Yes, thermostat
Ambient duty rating	+40 Deg. C
Operating speed, rpm, maximum	3,550
Voltage rating	460 volt, 3 Phase
Efficiency	NEMA Premium
Service Factor	1.00
Motor starting type	VFD, coordinate for proper starting of driven equipment.

Notes:

a. Because the pumps are to operate at constant speed, the pump shall be selected so that the rated condition lies within 5 percent (based upon capacity) of the best efficiency point (BEP) on the pump's head-capacity curve.

b. The motor shall be nonoverloading within the selection criteria set forth in Section 43 05 21. Pump selections which do not conform to this requirement without requiring a motor with a nameplate rating greater than that listed are not acceptable.

D. Vibration and Critical Speeds
   1. The pump shall comply with the requirements of Section 43 05 17.

2.03 MATERIALS

A. Materials of construction shall be as follows:

Component	Material
Suction/discharge base, pump head, flanges and couplings	316 Stainless Steel
Motor stool	Cast iron
Shaft	Stainless steel, Type 316
Impellers 1	316 Stainless Steel
Wearing rings	Teflon
Intermediate bearings	Graflon-grundfos only
Bottom bearing rings, shaft journal	Tungsten carbide, replaceable

Component	Material
Cartridge shaft seal	Per manufacturer, corrosion resistant, replaceable without disassembling pump (EPDM [std], Viton, or Buna O-rings)
Motor seal	Per manufacturer, replaceable without removing motor

Notes:

a. Impellers shall be balanced at the factory. Balancing of the impeller in the field is not permitted.

b. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials to provide greater strength or meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

2.04 EQUIPMENT MOUNTS

A. Mounting Plates
   1. Use Fabricated Steel Frame, Baseplate.
   2. Install mounting plates per Section 43 05 13.
   3. Mount plate leveled.
   4. Mount pump and motor on a common baseplate. Baseplate collects, contains, and directs seal water leakage to a single outlet.

B. Grout Type
   1. Use Epoxy Grout per Section 03 60 00.

C. Equipment Anchors
   1. Install per Structural Drawings.

D. Equipment Anchor Sleeves
   1. Install per Section 43 05 13.
   2. Length shall not be less than 15D (D = nominal bolt diameter; bolt diameter determined by mounting plate manufacturer).

E. Equipment Pad
   1. Install per Structural Drawings.

2.05 INSTRUMENTS AND CONTROLS

A. Pressure Gauges

B. Suction Pressure Transmitter

C. Discharge Pressure Transmitter

2.06 VFD CONTROL PANEL

A. Enclosure:
   1. NEMA 4.

B. Front or side of enclosure equipment:
   1. Main disconnect switch.
   2. Operator Interface for pump controller.
   3. VFD disconnect switches.
   4. Pump run pilots, green.
   5. Pump elapsed time meters.
   6. Pump cycle counters.
   7. Pump Hand-Off-Auto selector switches.

C. Interior enclosure equipment:
   1. VFDs.
   2. Pump controller.
   3. 480 volt surge arrestor.
   4. 480 to 120 volt control power transformer.

D. Interface to Telemetry/SCADA:
   1. Discrete inputs:
      a. System auto start (dry contact from Telemetry).
   2. Discrete dry contact outputs:
      a. System run.
      b. System fault alarm.
      c. Water shortage alarm.
      d. Phase loss alarm.
      e. VFD control panel intrusion alarm.
      f. For each pump:
         1) Hand-Off-Auto selector switch in Hand.
         2) Hand-Off-Auto selector switch in Auto.
         3) Run status.
         4) Alarm.
   3. Analog inputs:
      a. None.
   4. Analog outputs:
      a. Suction pressure.
      b. Discharge pressure.
      c. For each pump:
         1) Motor current.

2.07 SOURCE QUALITY CONTROL

A. Factory Tests
   1. Factory tests are not be required. However, the manufacturer shall guarantee the performance specified under paragraph 2.02 Operating Conditions, Condition A.

PART 3 EXECUTION

3.01 INSTALLATION

A. Each pumping unit shall be aligned, connected, and installed in accordance with the manufacturer's recommendations.

B. The installation shall be certified on Form 43 05 11-A as specified in Section 01 99 90.

3.02 FIELD QUALITY CONTROL

A. After completion of installation, each pumping unit shall be field tested to demonstrate compliance with the performance requirements as specified.
   1. A minimum of **2** hours of training shall be provided by the pump manufacturer's service representative.
   2. Training shall conform to Section 01 79 00.
   3. Certify completion of training on Form 43 05 11-B as specified in Section 01 99 90.

END OF SECTION

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SECTION 43 31 13.13

VERTICAL GRANULAR ACTIVATED CARBON LIQUID ADSORPTION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Scope:

1. This section specifies vertical pressure vessels using granular activated carbon (GAC) media for TDS removal after ultrafiltration in order to decrease the potential for DBP formation in distribution. This section specifies vertical pressure vessels including associated piping and valves and other appurtenances associated with the pressure vessels utilizing granular activated carbon (GAC) media for TDS removal after ultrafiltration in order to decrease the potential for DBP formation in the downstream distribution system. The GAC media is specified in Section 46 61 16. The initial load of resin or media shall be provided and installed by the pressure vessel supplier (System Supplier). The System Supplier shall furnish the inlet, outlet, and media exchange piping, valves, instrumentation, pressure relief valves, air release valves, and other associated appurtenances. The System Supplier shall provide pipe supports for the piping, valves, and other appurtenances as specified herein and throughout the Contract Documents and as indicated on the Drawings in order to provide a complete and fully functional GAC system.
2. The vessels will be installed inside, but potentially exposed to direct sunlight, at the LeChee Water Treatment Plant near Page, Arizona.

B. Equipment List:

Item	Equipment No.
GAC Contactor 1	PV2310
GAC Contactor 2	PV2320
GAC Contactor 3	PV2330
GAC LCP	N/A

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.

1. Section 01 11 80: Environmental Conditions
2. Section 01 33 00: Submittal Procedures
3. Section 01 43 33: Manufacturers Field Services
4. Section 01 66 00: Product Storage and Handling Requirements
5. Section 01 73 24: Design Requirements for Nonstructural Components and Nonbuilding Structures
6. Section 01 78 23: Operation and Maintenance Data
7. Section 01 99 90: Reference Forms
8. Section 09 90 00: Painting and Coating
9. Section 40 05 63.02: Ball Valve – Full Port [SS]
10. Section 40 05 64.03 High Performance Butterfly Valves

11. Section 40 05 57.23: Powered Actuators
12. Section 40 73 00: Pressure, Strain, and Force Measurement
13. Section 43 05 11: General Requirements for Equipment
14. Section 46 61 16: GAC Media
15. Section 40 67 00: Control System Panels and Racks

1.03 REFERENCES

A. This section references design standards. They are a part of this specification as specified and modified. In case of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASME	Boiler and Pressure Vessel Code, Section VIII, Rules for Construction of Pressure Vessels
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B31.3	Process Piping
ASTM A36	Standard Specification for Carbon Structural Steel
AWWA C207	Steel Pipe Flanges for Waterworks Service – Size 4 in. through 144 in.
ASTM A516	Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
NSF/ANSI 61	AWWA – Drinking Water System Components
SSPC	Paint Application Specification No. 1

1.04 ENVIRONMENTAL CONDITIONS

A. The units specified in this section shall be designed for outdoor operation. Environmental conditions will be as described in Section 01 11 80.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Unit Responsibility: The Design Builder shall assign unit responsibility as specified in Section 43 05 11 Unit Responsibility to the Supplier/Subcontractor for all equipment specified in this section.

B. All vessels shall be design, fabricated and inspected in accordance with ASME BPVC Section VIII Division 1. Supplier shall use the code editions adopted as defined in Arizona State law. All vessels shall be registered in with the National Board of Boiler and

Pressure Vessel Inspectors [NBBI] and shall be stamped with the applicable certification mark in accordance with ASME BPVC Section VIII.

C. All piping shall be designed, fabricated and inspected in accordance with the latest edition of ASME B31.3.

1.06 SUBMITTALS

A. Comply with procedures described in Section 01 33 00.

B. Action Submittals – Shop Drawings:

1. A copy of this specification section, with addendum updates included with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Owners Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. A Certificate of Unit Responsibility attesting that the contractor has assigned unit responsibility in accordance with the requirements of this section and Section 43 05 11-1.02 Unit Responsibility. No other submittal material will be reviewed until the certificate has been received and found in conformance with these requirements.
3. Copies of this specification section shall be numbered and marked (specification number and equipment number) for inclusion (filing) with the associated equipment submittal requirements.
4. A copy of the contract document process and instrumentation diagrams I-23-101, -102, and -103 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
5. A copy of the contract document Electrical and Instrumentation control one-line diagrams E-00-111, E-00-513 and -514, and E-00-701 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
6. A copy of all related structural and mechanical drawings with all piping, foundations, supports, and layout sizes and dimensions required for installation either confirmed by a checkmark or adjustments marked in red ink.

7. Equipment catalog information and equipment data including product literature, materials of construction, construction details, dimensions, piping connections, and weight of equipment. Clearly note model numbers, appurtenances, and selected options.
8. Structural design calculations per Section 01 73 24 stamped by a Structural Engineer registered in the State of Arizona. This includes calculations pertaining to the supports of the vessels themselves
9. Form 46 05 29-A, Rigid Equipment Mount Installation Checklist for all mounted equipment.
10. Provide data on superficial velocity and/or flow rate versus pressure drop through a single pressure vessel without adsorbent media installed during normal downward flow operations. The data shall include those at superficial velocity ranging from 1 gallon to 15 gallons per minute per square foot (gpm/ft^2) and/or flow rate ranging from 200 to 2,000 gallons per minute (gpm).
11. Standard media loading and unloading procedures.
12. ANSI/NSF 61 Certifications for all equipment and coatings in contact with potable water.
13. ASME Calculations demonstrating compliance with ASME Section VIII, Division 1 Pressure Vessel Code;
14. Certified copies of ASME inspection reports, including ASME certification. This includes, but is not limited to, all applicable Welding Procedure Specifications (WPS), Procedure Qualification Records (PQR), Welder Performance Qualifications (WPQ), Welding Operator Performance Qualifications (WOPQ), NDE Inspection Reports, Manufacturers Data Reports (U-1, U-2, etc.), Manufacturer's or Assembler's Certificate of Conformance for Pressure Relief Valves (UV-1). Manufacturer's Data Reports, NDE Inspection Reports, and Certificate of Conformances for Pressure Relief Valve documentation shall be furnished no later than the time of delivery of the vessels. All other documentation shall be furnished and approved prior to the start of fabrication.
15. Shop drawings for all equipment pads, equipment anchors, and baseplate, soleplate or mounting block details. Shop drawings shall depict size and location of equipment pads and reinforcement; equipment drains; equipment anchor, size, location, and projection; expansion joint locations; elevation of top of grout and grout thickness; elevation of top of baseplate; soleplate; or mounting block; size and location of electrical conduits; and any other equipment mounting features embedded in equipment pads. Shop drawings for equipment pads, equipment anchors, and baseplate, soleplate, or mounting blocks shall be numbered and marked (specification number and equipment number) for inclusion (filing) with the associated equipment submittal requirements.
16. Submittal requirements of Section 40 67 00 for the control panel.
17. Submittal requirements of Section 40 73 00 for pressure instruments.

C. Informational Submittals:
1. Procedures: Section 01 33 00.
2. Installation certification Form A 43 05 11.
3. Training certification Form B 43 05 11.
4. Certified copies of ASME inspection reports.

D. Closeout Submittals:
   1. Procedures: Section 01 78 23.
   2. Operating and maintenance submittals: Section 01 78 23. Include copy of final reviewed shop drawings submittal and as-built drawings.
   3. Spare Parts:
      a. Procedures: Section 01 33 00
      b. Provide the recommended spare parts list for the initial two years of operation.
   4. As-Comissioned PLC and HMI Program Files.

1.07 QUALITY ASSURANCE

A. The Supplier/Subcontractor shall be responsible to assure that the vessels furnished under this Section have the proper connections and are made of the proper materials to satisfy this and other applicable specifications and as shown on the drawings. Strict adherence to the standards of design, fabrication, product quality, and long-term performance is required by the Supplier/Subcontractor.

B. The entire system and connections shall be designed, fabricated, and supplied by a single manufacturer.

C. The Supplier shall be experienced in the design, construction, commissioning, and operation of pressure vessel systems specifically used for treatment for potable/drinking water supply, and shall have built and supplied a minimum of ten comparable and continuously operating pressure vessel systems of similar size, flow, and media capacity, as required by these Specifications, within the last 5 years. As part of the Proposal, the Supplier shall include documentation of relevant experience with system operation dates and size of installations (number of pressure vessels, system design flow rate, system media capacity in pounds of adsorbent per vessel, and vessel diameter).

D. Welding Procedures and Qualifications
   1. Welding Procedure: Weld procedure used for the qualification of welders shall be witnessed and evaluated by a certified AWS QCI welding inspector from and independent testing laboratory utilizing calibrated equipment.
   2. Qualifications of Welders:
      a. Welders shall be qualified for the welding process and the procedure to be used under ASME Boiler and Pressure Vessel Code, Section IX, Part QW for all welds pertaining to the pressure boundary welding of supports and other appurtenances welded at the interface between the component and the surface of the vessel pressure boundary and all piping. All other welding shall be welded and AWS Structural Welding Code, Section 5.
      b. Welders shall have verifiable evidence that their qualification is current and valid under the applicable code, including documentation indicating continuity between initial certification and current time.
      c. Welder Qualification Certification shall be witnessed and evaluated by a certified AWSS QCI welding inspector from an independent testing laboratory utilizing calibrated equipment.
   3. Welding Tests
      a. The owner has the option of requesting tests, as noted below.

b. Test Methods:

X-ray: Paragraph UW-52, Section VIII, ASME Boiler and Pressure Vessel Code. Other non-destructive tests.

c. Test Coupons:

In accordance with ASTM E-8. Welded seam shall develop strength of adjacent sheet or plate.

d. Cost of tests:

Test failure: Cost borne by Contractor including follow-up tests after repair. Test satisfactory: Cost borne by Owner as extra work.

4. Certification of Welders
   a. Certification of welders: Submit verifiable evidence of qualification to the Engineer at least seven days prior to work.
   b. Submit welding procedures with supporting qualification records for approval.

E. GENERAL WELDING PROCEDURES
   1. Use Gas Metal Arc Welding (GMAW), Gas Tungsten Arc Welding (GTAW) or flux cored arc welding (FCAW) method, unless the Engineer approves another method prior to use. Circumferential seams may additionally utilize automated Submerged Arc Welding (SAW).
   2. Welds shall be fused with metal base, uniform in appearance, free from cracks and reasonably free from irregularities.
   3. Restart in weld zone on clean and sound metal.
   4. Limit porosity and slag inclusions in accordance with Section VIII, ASME Boiler and Pressure Vessel Code.
   5. Repair defective welds by chipping, grinding, flame gouging, or air-arc gouging.
   6. Do not undercut alongside of finished pass.
   7. Use procedures or welding sequences that will minimize eccentric stresses, shear or distortion in the weld.
   8. Butt welds shall have complete penetration and fusion.
   9. Finished weld bead shall be central to the seam.
   10. Artificial or forced cooling of welded joints is not permitted.
   11. Low hydrogen electrode storage shall be in accordance with AWS D.1., Article 4.5.
   12. Manual welding shall be performed in two layers.
   13. Passes shall not exceed ¼ inch in throat dimension.
   14. Welds shall be thoroughly cleaned after each pass.

1.08 DELIVERY, STORAGE AND HANDLING

A. The equipment shall be protected during shipment as specified in Section 01 66 00.

B. Ship equipment, materials, and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.

C. Where applicable, pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.

D. Provide short-term and long-term storage requirements to the Design-Builder.

1.09 WARRANTY

A. The Supplier shall furnish a written one-year equipment warranty for the GAC System and internals specified under this procurement. The warranty period shall begin upon acceptance of the final performance testing and system acceptance by the Design-Builder. The equipment shall be warranted to be free of defects in materials and workmanship and to meet the performance criteria.

B. Corrosion resulting from improper coating of the interior of the pressure vessel is specifically included as part of this warranty.

PART 2 PRODUCTS

2.01 DESIGN BUILDER FURNISHED EQUIPMENT

A. The Design Builder will furnish and install the piping and appurtenances where excluded from the Supplier/Subcontractor's scope. The Supplier/Subcontractor's scope is noted herein and delineated on the P&IDs. Piping shall be supported on a pipe rack designed and provided by the GAC System Supplier (Manufacturer)

B. Manufacturer shall provide a complete working system including all piping, valves, actuators, instrumentation and appurtenances to automate operation of the system.

C. The GAC contactor vessels shall be supplied by one of the following manufacturers:
   1. Calgon
   2. Evoqua
   3. Or approved equal.

2.02 PERFORMANCE/DESIGN CRITERIA

A. Service Conditions

Characteristic	Value
Service Conditions	Surface Water Treated with an Ultrafiltration System
Area Exposure	Indoor per Section 01 11 80
Fluid Temperature Range, °C	7.9 to 12.6

B. Operating Conditions:

Description	Value
Maximum Flow Rate per Vessel (gpm)	350
Design Flow Rate per Vessel (gpm)	350
Total Empty Bed Contact Time at Design Flow, All Vessels In Service, minutes	15
Allowable headloss based on 10,000 lbs GAC, inlet flange to outlet flange at design flow rate	12-15 psig [1]

Notes:

1. *Allowable headloss directly affects the allowable water surface elevation of the finished water reservoir downstream of the GAC system. Manufacturer shall provide options to Engineer to minimize headloss across the system if available.*

C. Physical Design Criteria:

Description	Value
Pressure Vessels	
Maximum Allowable Working Pressure	125 psig
Minimum Design Metal Temperature	20 °F
Number of Vessels per System	3
Number of Systems	1
Diameter, ft	8
Orientation	Vertical
Height	As required by pressure vessel manufacturer to achieve a 30% bed expansion of GAC media without any measurable media losses (less than 5 percent per year) or clogging of the underdrain system and inlet distributor/backwash collector
Media	GAC per Section 46 61 16 with ability to change to virgin bituminous coal based carbon (Calgon F400 or equal) in the future
Minimum Media Capacity Per Vessel, lbs	Up to 10,000
Backwash	
Minimum Washwater Loading Rate, gpm/sf	3.0
Maximum Washwater Loading Rate, gpm/sf	12.0

2.03 SYSTEM OPERATION

A. Configure GAC system such that it is capable of operating with either all vessels in parallel or in lead-lag-polish (for pairs of GAC vessels) where the lead vessel can become the lag vessel, and the lag vessel can become the polish vessel and the polish vessel can become the lead vessel and so forth. The GAC system will typically operate with all units online and in series. One vessel may be taken offline if Empty Bed Contact Time (EBCT) may be achieved with two vessels based on demand.

B. The GAC system will operate alongside an active flow bypass meant to minimize the flow rate the GAC system must treat.

C. All valves necessary to allow for changing the process order of the vessels, taking a vessel offline as well as allow for automatic backwashing shall be automated with electrical actuators.

D. Provide backwash system capable of being initiated based on maximum pressure loss across the GAC media, or contactor run time.

E. Typically, all GAC contactor vessels will remain in service. Vessels will be drained of water and taken offline when not in use for any extended periods. Provide any special provisions necessary to accommodate this service cycle as part of each pressure vessel, including but not limited to, small manual drains and mesh filters on all dead legs such as the media removal lines to allow the system to be fully drained of water without loss of media.

2.04 MATERIALS

A. Periodic disinfection of vessel components may be required using chlorine, or chloramines. As such, all immersed vessel components shall be suitable for exposure to exposure to chlorine.

B. Materials for water-bearing components shall be ANSI/NSF 61 certified.

C. Materials of construction shall be as follows:

Component	Material
Vessel	ASTM A-516 Gr. 70
Structural Steel	ASTM A-36
Inlet Distributor/Backwash Collector/Underdrain	316 Stainless Steel
Underdrain nozzles	316 Stainless Steel

D. All Stainless Steel components shall be protected, cleaned and tested as follows:

1. Stainless steel components shall be protected from carbon steel contamination during fabrication and assembly as defined in Paragraph 8 of ASTM A380. Surfaces surrounding joints shall be cleaned as discussed in Paragraph 6.3 prior to welding. Careful adherence to good stainless-steel practices may minimize descaling and cleaning requirements.
2. Welding temperatures shall be carefully monitored as to not sensitize the material and thereby increase the risk of intergranular corrosion.
3. After completion of welding, all surfaces shall be descaled as necessary using methods described in Paragraph 5 of ASTM A380. Welded surfaces (including surfaces within the heat affected zone of the weld) shall be descaled using a pickling solution as discussed in Paragraph 5.2. Surfaces shall be thoroughly rinsed in accordance with Paragraph 5.2.5.
4. Following descaling, all surfaces shall be cleaned as necessary using methods described in Paragraph 6 of ASTM A380. Final cleaning of all surfaces shall be in accordance with Paragraph 6.4 of ASTM A380.
5. Upon completion of cleaning, all surfaces shall be visually inspected in accordance with Paragraph 7.2.1 prior to testing. Any gross indications of Iron as defined in Paragraph 7.2.1.1 shall be cleaned as necessary.
6. Testing to ensure proper passivation and cleaning has occurred shall be as defined in Paragraph 7.2.5 of ASTM A380. First, perform a water-wetting and drying test on all stainless-steel surfaces in accordance with Paragraph 7.2.5.1 of ASTM A380 or a Practice A – Water Immersion Test as defined in Paragraph 14.1 of ASTM A967. Failed areas shall be re-cleaned and retested using a Copper Sulfate Test in accordance with Paragraph 7.2.5.3 of ASTM A380 or Practice D – Copper Sulfate Test found in Paragraph 14.4 of ASTM A967. Any remaining failed areas shall be cleaned using a nitric acid solution in accordance with Table A2.1 Part II of ASTM A380 followed by retesting of all affected areas using a Copper Sulfate Test.
7. Manufacturer shall notify Engineer of any failed tests. No equipment shall be shipped without certification that all surfaces have passed inspection and testing. Manufacturer shall remove test chemical in accordance with the testing manufacturers recommendations. No visible indications of Iron may exist prior to shipment. Any evidence of rust or blooming upon arrival on site shall be the responsibility of the manufacturer to address.

8. The manufacturer shall supply a cleaning, passivation and testing procedure outlining the procedure followed by the manufacturer to ensure proper cleaning and passivation has occurred along with test results upon completion of the testing.

2.05 CONFIGURATION, COMPONENTS, FEATURES

A. General:
   1. Provide a complete set of GAC vessels including, but not limited to the following:
      a. Carbon adsorbers with internals for carbon retention
      b. Influent, effluent and backwash piping with valves
      c. Carbon fill and discharge piping with valves
      d. Vent and pressure relief piping
      e. Water piping and utility connections
      f. Sample ports and lines
      g. Accessories

B. Pressure Vessel:
   1. The vessels shall be designed, constructed, and stamped in accordance with ASME Section VIII, Division 1, and shall be registered with the National Board for a minimum design pressure rating of 125 psig at 140 degrees F.
   2. The pressure vessels shall be of welded steel construction using SA-516 Grade 70 steel.
   3. Vessels shall be provided with one 24-inch elliptical manway on the sidewall and one 14-inch by 18-inch, minimum, manway on the bottom head. Manways shall be complete with manhead, yoke, and gasket. Manways shall be oriented to allow operator access based on the layout down in the process mechanical drawings.
   4. Vessels including support systems and anchors shall be designed and installed in accordance with Section 01 73 24. Structural calculations shall be performed and signed by a structural engineer registered in the State of Arizona.
   5. Vessels shall be factory-tested in accordance with UG-99 Standard Hydrostatic Test.
   6. Each pressure vessel shall be free standing using four (4) I-beam legs to support the vessel.
   7. Provide flanged connections for inlet/outlet piping and as needed for operation of the vessels.
   8. Provide support points for influent piping, air release piping, carbon fill piping, spent carbon outlet piping, sample piping, and vent piping integral to each vessel.
   9. Design the vessel with an adjustable GAC removal system to allow for removal of the spent GAC in 10,000 lb. increments.

C. Inlet Distributor/Backwash Collector:
   1. Provide a header/lateral type or weir/trough type inlet distributor/backwash collector system for each vessel, designed for even distribution of flow over the entire GAC media bed and for the uniform collection of backwash water during the backwash cycle.

2. Make provisions for field leveling the distributor/collector to ensure uniform distribution/collection. The distance from the underdrain system to the backwash collector shall be not less than the depth of 10,000 lbs of GAC, with 30% expansion, plus an additional 2 feet.
3. Design the distribution system such that it can be dismantled and reassembled from within the vessels without cutting any vessel or distribution system physical members.
4. Design header/lateral type distributors with type 316 stainless steel pipe and threaded fittings. Laterals shall terminate in upturned 90 degree elbows with vertical piping extending from the upturned elbows providing the specified freeboard.
5. Design weir/trough type distributors with type 316 stainless adjustable weir plates. Design shall prevent the carryover of GAC media during the backwash cycle. Trough shall run the full diameter of the vessel and shall be perpendicular to the inlet pipe in order to promote even distribution of water over the GAC surface.

D. Underdrain System:
1. Design each vessel with either an external header/septa type underdrain, an external piping ring underdrain system or an internal cone underdrain system that supports the GAC bed, collects GAC treated water, provides uniform distribution of the treated water, and facilitates GAC removal without the need to open the manway to manually hose out the remaining spent GAC.
    a. For the dual piping ring, provide a minimum of eight septa and design to allow replacement of the septa without the need to remove external piping.
    b. For the internal cone underdrain, weld cone to the tank wall around the entire circumference to form a watertight seal between the media chamber above and the water inlet chamber below.
    c. Maldistribution of any of these flows shall not exceed 5 percent over any part of the underdrain system.
    d. The underdrains shall reduce the water velocity, discharging the water horizontally without impeding its flow, thereby preventing channeling in the GAC bed.
    e. Underdrains shall be designed to withstand the weight of the media bed in a floored state.
    f. Under no circumstances shall the GAC media be upset during normal backwash procedures.
2. Manufacturer shall provide pressure loss information for all three underdrain options and shall provide any other design options available to reduce overall pressure drop across the filters.
3. The GAC System Manufacturer shall install the underdrain system prior to shipment.
4. Costs for any repairs or replacement of the underdrain system or GAC media as a result of poor distribution or media upset shall be borne solely by the GAC System Manufacturer.
5. All underdrain material internal to the vessel or in contact with the media (including septa) shall be 316L stainless steel. Septa slot size shall be 0.008 inches.
6. GAC traps shall be designed and installed to preclude entry of resin or media into distribution system in the event of an underdrain failure. Traps shall be installed on the discharge of each vessel.

E. GAC Media

1. One (1) complete GAC media load shall be provided for installation by the contractor. Vessels shall be provided with GAC media as specified in Section 46 61 16 required by the Adsorption System manufacturer.
2. The Adsorption System manufacturer's representative shall witness initial installation of the GAC media, and shall promptly notify the consulting engineer in the event that the contractor deviates from the manufacturer's installation instructions, or should any irregular or unusual events occur during installation of the adsorption equipment. Upon completion, the manufacturer shall furnish a letter to the engineer stating that the installation was witnessed by the manufacturer, or an authorized representative, and that the media was installed in accordance with the manufacturer's recommendations.

F. Connection Schedule:

1. Vessels shall be furnished with the connections identified on the P&IDs. Exact locations to be provided during submittal reviews and the Design-Builder will furnish the plant 3D model to facilitate nozzle locations.
2. Connection orientation will be identified in the submittal review process and coordination with the Design-Builders 3D model.

G. Piping:

1. Provide piping for influent water to the system and pressure vessels, treated water (effluent) from the pressure vessels and system, pressure vessel backwash water supply and waste, vent lines, and media fill and removal piping.
2. The influent and effluent pipe network allows series (Lead/Lag/Polish) and parallel only operating modes. Lead/Lag/Polish operation shall allow any of the three vessels to act as the Lead, Lag or Polish operation in any order. The change in flow pattern is accomplished with a change of valve positions. The purpose of lead/lag operation allows an adsorber to act as an on-line backup and/or provides for sufficient contact time to allow adsorption of the contaminants of concern.
3. Process piping (influent, effluent and backwash) sizes will be as shown on the P&Ds . Section 40 05 02 defines the Process System Identification provided on the P&IDs next to each pipe size and references the applicable sections associated with each Process System Identifier.
4. Provide the piping network with a structural steel support frame for support of the piping module. Provide additional external pipe supports necessary to support all Supplier-provided piping.
5. Sample Ports:
    a. Provide a minimum of four combined carbon and process water sample ports. to collect carbon bed and water quality samples from each vessel. Sample port locations should target empty bed contact times of 15%, 40% 65% and 90%of 10,000 lb bed depth. Additional sample ports can be provided. The Design-Builder is open to Supplier/Subcontractor's suggestion on sample port locations. Carbon sample port size and design shall be Supplier standard design. Water quality sample lines shall terminate at an elevation that can be easily accessed for operator sample collection.

6. Fill Ports and Lines:
    a. Provide a GAC fill port and line with carbon fill piping. The Engineer is open to the Manufacturer's suggestion on GAC fill port location. Lines shall terminate at an elevation that can be easily accessed for fresh GAC fill hose connection and shall have a male quick connect terminal with cap a 2" water connection, and ¾" compressed air connection.
7. Vent Line
    a. Provide a 1" diameter vent line for the underdrain. The Engineer is open to Manufacturer's suggestion on vent port location. Line shall terminate at an elevation that can be easily accessed for operator manual operation.
    b. Provide a 3" diameter vent line for the main portion of the vessel. The Engineer is open to Manufacturer's suggestion on vent port location. Terminate line at an elevation that can be easily accessed for operator manual operation.
8. Spent Port and Lines:
    a. Provide one spent IX or GAC port and line at the bottom. Nozzle must be adjustable to account for variations in media densities. Line shall terminate at an elevation that can be easily accessed for spent IX resin and/or GAC media removal, no more than 4' above finished floor, and shall have a flanged stainless steel ball valve and male quick connect terminal with cap. Construct utility piping of threaded schedule 80 carbon steel, ASTM 53 Grade B materials.

H. Valves
1. Equip the process and utility piping (excluding GAC fill and discharge piping) with butterfly valves, as indicated on the Drawings, to accommodate the process and backwash control functions per Section 40 05 64.
2. For the carbon fill and discharge valves, provide 316 stainless steel construction with TFE seats full port ball valves per Section 40 05 63.03.
3. Provide 1" steel ball valves on each sample line per Section 40 05 63.03.
4. Utility valves for the compressed air supply shall be ball valves per Section 40 05 63.03
5. Size valves with the same diameter as the process pipe to accommodate maximum system flow.

I. Actuators:
1. Provide motorized actuators per Section 40 05 57.23 to allow for automatic backwash, process control, and vessel sequence as indicated on the Drawings.

J. Lifting Lugs:
1. Each vessel shall include four (4) external top mounted lifting lugs and one bottom mounted tailing lug suitable for lifting and placing the vessel into position.

K. Instrumentation
1. Design instrumentation to be accessible from grade.
2. Mount a 3" rupture disk constructed of impervious graphite off each vessel's vent line and vent to atmosphere. Design to relieve pressure at the design pressure of the vessel and at the maximum flow to the system.
3. Provide each vessel with a differential pressure switch per Section 40 73 00.

4. Equip the process piping with pressure gauges per Section 40 73 00 to indicate the pressure entering and exiting each adsorber.

L. Miscellaneous
   1. Fit the carbon fill and discharge with hose connections, such that carbon transfer to and from the adsorbers can be facilitated using carbon transfer hoses. These connectors will be 4" Quick Disconnect Adaptors constructed of aluminum as manufactured by Dover Corp. as Kamlock connectors or equal.
   2. Weld two (2) flush connections on each GAC fill line, one upstream and one downstream of the valve. Weld one (1) flush connection on each GAC discharge line, downstream of the valve.
      a. Flush connections will consist of a short section of ¾" pipe, a ¾" full port ball valve per Section 40 05 63.09 and a ¾" quick disconnect adaptor to match with water hose fittings.
   3. Provided a molded neoprene reinforced rubber expansion joint which allows 4 way movement and 30° angular misalignment for the influent and effluent pipe for each vessel.

2.06 COATINGS

A. All paints, coatings, and sealants to be in contact with water shall be NSF 61 listed.

B. Fabricated steel or ferrous metal vessel components shall be fully prepared and coated in accordance with the requirements of Section 09 90 00.

C. Interior surfaces of all pressure vessels shall be completely factory finish painted prior to shipment with a suitable coating system for GAC potable water service. Interior surfaces shall be sandblasted to SSPC-SP5/ NACE 1 near white blast, and coated with a vinyl ester resin specifically formulated for abrasion resistance and tank lining service (Carboline Plasite 4110 or equal), to a total dry film thickness of 35-45 mils MDFT.

D. Vessel exteriors shall be factory primed and finished using Section 09 99 00 system EU-

E. All piping surfaces will be prepared by blasting per SSPC-SP7.

F. The exterior surface of the piping will be painted to a dry film thickness of 5 to 7 mil with a high solids epoxy (gray color) paint material prior to assembly to ensure minimum oxidation at flanged connections.

G. Supplier/Subcontractor shall provide a 5 gallon container of each factory coating component necessary to field repair damage to the factory internal and external coatings with the coating manufacturer's application instructions.

H. The equipment warranty specified in this Section shall include a warranty on the coating system.

2.07 CONTROL PANEL

A. The GAC system shall be controlled by a control panel per Section 40 67 00.
   1. PLC per Section 40 63 43.

2. HMI shall be Schneider Electric Harmony GTO.
3. Control per Section 40 61 96.

B. Enclosure shall be NEMA Type 4X Type 316 stainless steel.

C. Power: 120Vac.

D. Control panel shall provide power to all actuated valves.

PART 3 EXECUTION

3.01 MANUFACTURERS SERVICES

A. Installation, testing, training and commissioning shall be performed in accordance with Sections 01 43 33. The Supplier/Subcontractor shall provide a factory representative, knowledgeable of the system and components, to inspect the final installation, supervise the initial testing and operation, and train necessary personnel in the proper operation and maintenance for the system, certified on Form 43 05 11-A.

B. Provide 8 hours on site of manufacturer's programming for coordination of PLC and any Operator Interface programming per Section 40 68 03.

C. A pre-commissioning service visit shall be provided to inspect the installation of the vessels, with a minimum of 4 hours on site.

D. A vessel filing service visit shall be provided to assist with loading carbon and initial backwashing, with a minimum of 16 hours on site over two (2) days.

E. Provide a startup service visit to assist with system startup and training, with a minimum two visits for a total of 24 hours (3 days) onsite each trip. Training shall be certified on Form 43 05 11-B.

END OF SECTION

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SECTION 43 41 43.13

HIGH DENSITY CROSSLINKED POLYETHYLENE TANKS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section specifies crosslinked high-density polyethylene tanks for chemical storage.

B. Type:

1. Unless otherwise specified, tanks shall be circular cross-section, vertical, complete with piping outlets, drains, overflows, and anchoring system. Covered tanks shall be vented, and where specified, tanks shall be provided with entrance manways, level indicators, electrical heat tracing, spray-on urethane foam insulation, and exterior coating.

C. Equipment List:

Item	Equipment No.
Membrane Backwash Tank	T2240
CIP Tank	T2250

D. Design Requirements:

1. Physical Characteristics: Chemical storage tanks provided under this section shall have the following characteristics:

Equipment number	T2240	T2250
Type[3]	CD	CD
Nominal diameter [7], ft	5.0	5.0
Nominal height,[4] ft	7.5	14.0
Liquid depth, ft	7.5	11.5
Nominal capacity, gallons	1,100	1,900
Manway:[5]		
• Mounting[6]	TM	TM
• Diameter, inches	15.0	15.0
• Exposure	Indoors	indoors

Notes:

1. *Tanks shall be provided with level indicator.*
2. *Tanks shall be provided with molded flange full drain fitting. (IMFO)*
3. *CD = closed, domed top; CF = closed, flat top; OIF = open, internal flange; OEF = open, external flange; FLR = flat lid removable; FLH = flat lid hinged.*
4. *Nominal height of domed top tanks is the dimension measured along the straight cylindrical portion of the tank and does not include the rounded end.*
5. *Unless otherwise specified, manways shall be integrally molded with the tank.*
6. *TM = top mount; TSM = top and side mount.*
7. *Do not exceed diameter defined in this table to maintain acceptable footprint in building.*

2. Operating Conditions: Chemical storage tanks provided under this section shall be suitable for the following operating conditions:

Equipment number	T2240	T2250
Chemical stored	Water	CIP Cleaning Solution (Three Potential Types) CIP Neutralized Solution (Three Potential Types)
Concentration, mg/L	N/A	[C1] 500 mg/l NaOCl [N1] C1 + 650 mg/L $NaHSO_3$ [C2] 500 mg/L Citric Acid + 800 mg/L H_2SO_4 [N2] C2 + 600 mg/L NaOH [C3] 2000 mg/L Citric Acid + 800 mg/L H_2SO_4 [N3] C3 + 500 mg/L NaOH
Unit weight, lb/gal	62.4	62.4
Design specific gravity	1	1
Solution pH	N/A	2.1 pH C1 | C2 | C3 Solutions 6 – 9 pH N1 | N2
Maximum fluid temperature, deg. F	80	110
Minimum fluid temperature, deg. F	40	40
Minimum ambient air temperature, deg. F	60	60

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI A58.1	Minimum Design Loads for Buildings and Other Structures
ASTM C177	Steady-State Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus
ASTM D638	Tensile Properties of Plastics
ASTM D746	Brittleness Temperature of Plastics and Elastomers by Impact
ASTM C273	Shear Properties in Flatwise Plane of Flat Sandwich Constructions or Sandwich Cores

Reference	Title
ASTM D1505	Density of Plastics by the Density Gradient Technique
ASTM D1525	Vicat Softening Temperature of Plastics
ASTM D1621	Compressive Properties of Rigid Cellular Plastics
ASTM D1622	Apparent Density of Rigid Cellular Plastics
ASTM D1623	Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
ASTM D1693	Environmental Stress-Cracking of Ethylene Plastics
ASTM D2126	Response of Rigid Cellular Plastics to Thermal and Humid Aging
ASTM D2842	Water absorption of Rigid Cellular Plastics
ASTM D2856	Open Cell Content of Rigid Cellular Plastics by the Air Pycnometer
ASTM E84	Surface Burning Characteristics of Building Materials
NEMA ICS 6	Enclosures for Industrial Control and Systems
Phillips Chemical Technical Bulletin SSL-193	Impact and Gel Testing
UBC	Uniform Building Code

B. Factory Test:
   1. Following fabrication the tanks, including factory applied pipe outlet fittings, shall be hydraulically tested with water. Test methods may include adding a 2.5 psig air pad to filled tanks or filling the tanks with standpipes, raising the maximum water surface approximately 6 feet higher than the normal maximum tank level. The test duration shall be 24 hours with proof of acceptance being an affidavit signed by the factory inspector. Following successful testing, the tank shall be emptied and dried prior to shipment.

C. Manufacturer's Warranty:
   1. The tank shall be warranted for 7 years to be free of defects in material and workmanship. Warranty shall be prorated over the last 5 years.

D. Manufacturer's Experience:
   1. The tank manufacturer shall have a record of at least ten installations during the previous 5 years for the tank sizes specified. The manufacturer must be capable of providing names of users and specific locations which can be visibly inspected.

E. Unit Responsibility:
   1. The Contractor shall assign unit responsibility as specified in Section 43 05 11-1.02 Unit Responsibility to the membrane treatment equipment manufacturer for all equipment specified in this Section that is provided with the equipment specified in 46 61 33.

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are

indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Certificate of Unit Responsibility attesting that the Contractor has assigned, and that the manufacturer accepts, unit responsibility in accordance with the requirements of this Section and Section 43 05 11-1.02 Unit Responsibility. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.
3. Tank manufacturer's data and dimensions showing locations of all openings, location of level sensors, seismic support structure and anchoring system details, and location of tank accessories.
4. Details on outlet fittings, flexible connections, and vent and level indicator.
5. Manufacturer's experience required in paragraph 1.02 Manufacturer's Experience.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. The tanks specified in this section shall be manufactured by Poly Cal Plastics, Inc., Poly Processing, Nalgene, or equal, modified to provide the specified features.

2.02 TANKS

A. The tanks provided under this specification shall be constructed of high-density crosslinked polyethylene using a rotationally molded fabrication process. Resin used in the tank shall be equal to Phillips Chemical crosslinked polyethylene Marlex CL 200 or equal and shall contain 1/2 to 1 percent ultraviolet stabilizer. Where black tanks are specified, the black resin shall contain 3 percent carbon black blended into the resin. The tank material shall meet or exceed the following test properties:

ASTM Test	Parameter	Value
ASTM D1505	Density, gms/cc	0.930-0.933
ASTM D1693	Environmental stress cracking, F50, hrs	>1,000
ASTM D638	Tensile strength, ultimate, psi, 2-inch minimum	2,600
ASTM D638	Elongation at break, percent, 2-inch minimum	450
ASTM D746	Brittleness temperature, degrees F	<-180
ASTM D1525	Vicat softening point, degrees F	255
Phillips SSL-193	Impact resistance at -40 degrees F, ft/lb	>120
Phillips SSL-193	Percent gel, innermost 1/32 inch of inner wall	>65
--	Percent gel, outermost 1/32 inch of outer wall	>90
--	Percent gel, entire wall thickness	>80

B. Wall thickness of the tank shall be designed by the manufacturer with a hoop stress no greater than 500 psi and a safety factor of no less than 2 using the Barlow formula. Calculations shall be based on design specific gravity specified in paragraph 1.01 Operating Conditions.

C. The tank manufacturer shall provide a certificate attesting that the tank materials meet or exceed the test properties specified above. Such certificates shall be signed by an officer of the manufacturer's corporation and shall be notarized.

2.03 TANK FITTINGS

A. Tank fittings shall be according to the fitting schedule below. Gasket material shall be closed cell, crosslinked polyethylene material equal to the material specified in Paragraph 2.02. PVC fittings shall be compression type Schedule 80 long shank high-torque design with minimum of 85 percent threaded contact. No metals shall be exposed to tank contents.

Equipment Number	T2240	T2250
Fill Line	DB-SS	DB-SS
Overflow	DB-SS	DB-SS
Tank Drain	IMFO	IMFO
Outlet to Pump	IMFO	IMFO
CIP Heat Recirculation	N/A	DB-SS
CIP Recirculation	N/A	DB-SS

Notes:

[1]Refer to drawings for fitting size and location. Legend for abbreviations:

DB-H: Double bolt with Hastelloy-C studs and polyethylene encapsulated heads.

DB-SS: Double bolt with 316 SS studs and polyethylene encapsulated heads.

IMFO: Integrally molded flange.

PVC: Double-nut PVC fitting.

2.04 LEVEL INDICATORS

A. Level indicators shall be provided where specified. Graduations shall be provided at every 200-gallon interval with 1,000-gallon intervals clearly labeled for bulk storage tanks. Unless otherwise specified, graduations shall be marked on the tank exterior. The level indicator shall be completely assembled to the tank and shall consist of PVC float, indicator, polypropylene rope, perforated interior pipe, PVC roller guides, clear sun and chemical resistant sight tube, and necessary pipe supports. The level indicator shall act inversely to the tank contents and shall not allow entrance of tank contents into the sight tube at any time.

2.05 SEISMIC RESTRAINT SYSTEM

A. The tanks shall be provided with seismic restraint systems manufactured in conformance with plans and instructions prepared and stamped by a registered structural engineer. The lateral restraint assembly shall be designed for seismic zone as outlined in in Section 01 73 24.

2.06 SAFETY SIGNS

A. Each tank inlet and tank outlet shall be clearly marked with hazardous material warning signs, 10 inches by 14 inches in size. Each sign shall have the words "DANGER" and the name of the chemical stored, printed in large block letters and mounted directly adjacent to the tank outlet and tank inlet. Each entry manway shall be provided with a sign ("DANGER--CONFINED SPACE--HAZARDOUS ATMOSPHERE").

2.07 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Applicable operation and maintenance information as specified in Section 01 78 23.
   2. Signed affidavit by the tank manufacturer indicating that the tank was successfully factory tested as specified in paragraph 1.02 Factory Test.
   3. Copy of manufacturer's warranty specified in paragraph 1.02 Manufacturer's Warranty.
   4. Certification of tank material test data as specified in paragraph 2.02.
   5. Signed affidavit that the heat tracing has been tested. All test results shall be submitted with the affidavit.
   6. Manufacturer's recommendations for installation.
   7. Seismic restraint plans and instructions specified in paragraph 2.07.
   8. Installation Certification Section 43 05 11-Form A specified in paragraph 3.01 Tanks.

PART 3 EXECUTION

3.01 INSTALLATION

A. Tanks:
   1. The tanks shall be installed as specified and in accordance with the manufacturer's written instructions. Prior to being placed in service, tank installations shall be checked by a factory-trained representative of the manufacturer, who shall fill out and submit the Installation Certificate Form 43 05 11-A in Section 01 99 90.

B. Tank Insulation:
   1. Tank insulation shall be applied only by the tank manufacturer. Proper adhesion of the foam to all surfaces shall be the responsibility of the manufacturer. The final foam surface shall be free from bumps, rings, pinholes, voids, and depressions. Mating surfaces of piping flange connections and other items noted by the Construction Manager shall be kept clear of insulation.

3.02 FIELD TESTING

A. Field testing shall be in accordance with requirements in Section 01 45 20 and as specified herein. Each tank shall be field tested by filling entire contents with water and monitoring the tank as well as all fitting connections for at least 24 hours. Any leaks shall be corrected by the manufacturer's representative prior to acceptance. Following successful field tank testing, the tank shall be completely emptied and dried.

3.03 SAFETY

A. Appropriate sections of the safety precautions outlined by Cellular Plastics Division of the SPI, the NFPA, OSHA, and the material manufacturers shall be followed. All personnel shall be familiar with the hazards involved in the use of equipment and materials on the project and the proper techniques and procedures to safely handle and apply the materials.

END OF SECTION

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SECTION 43 42 21

WELDED STEEL BLADDER SURGE TANK

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section specifies a plant (potable) water hydropneumatic tank for surge control at the Pump Station No. 3 Building.

B. Type:

1. The Tank furnished under this specification shall be of the welded steel vertical type, cylindrical in shape, with semi-elliptical heads, a replaceable internal butyl rubber diaphragm, and constructed in accordance with the ASME Pressure Vessel Code requirements.

C. Equipment List:

Item	Equipment No.
Pump Station No. 3 Hydropneumatic Tank	HT-1

D. Performance and Design Requirements:

1. The hydropneumatic tank stores water downstream from the Grundfos Boosterpaq Pump Skid as shown on Volume 3 drawings M-101 and M-102, which will be used for surge control of the booster pumps located in the same facility. This water will have a temperature range from 50 degrees F to 80 degrees F and a pH that varies from 6.5 to 8.5. System working pressure will range from 310 to 350 psig; system low pressure will be set at 300 psig.
2. Operating and design requirements are as follows:

Item	HT-1
Service	Potable Water
Type	Vertical
Overall tank height, inches	98
Diameter, inches	36
Minimum tank volume, gallons	300
System design pressure, range psig	310 – 350
Relief valve capacity, CFM	100
Relief valve setting, psig	360
Tank design pressure, psig	400

1.02 QUALITY ASSURANCE

A. General:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASME	Boiler and Pressure Vessel Code, Section VIII
ASTMA48-83	Gray Iron Castings
IBC 2006	International Building Code

B. Unit Responsibility:

1. The Design Builder assigns unit responsibility, as specified in Section 43 05 11, to the tank manufacturer for the equipment provided under this section. A completed, signed, and notarized Certificate of Unit Responsibility (Section 01 99 90-Form 43 05 11-C) shall be provided.

1.03 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 00.

B. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Supplier, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Design Builder shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Supplier with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

C. Certificate of Unit Responsibility attesting that the Supplier has accepted unit responsibility in accordance with the requirements of this section. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.

D. Catalogue information for carbon steel tank (and coating system).

E. Manufacturer's data including tank weight, materials of construction, welding procedures, and fabrication drawings for tanks and tank supports. Fabrication drawings shall include all dimensions, elevations, piping connections, accessories, locations, sizes, and details for all fittings and tank anchorage.

F. The Supplier is required to furnish construction drawings for all work not shown in complete detail on the bidding drawings. All such submissions shall be stamped by a Registered Professional Engineer licensed in the Commonwealth of Virginia and employed full-time on the tank manufacturer's engineering staff.

G. All drawings shall include materials lists and gross and net weights of the equipment.

H. Paint and primer material and preparation procedures in accordance with Section 09 99 00.

I. List of tank materials, appurtenances, and tank coating specifications.

J. Not used

K. Manufacturer's standard published warranty.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. Hydropneumatic tank shall be Hanson Tank, Wessels Tank Co., Pulsco Corporation, Young Engineering, ZZ Technology, Wagner Plate Works, Charlatte or equal, modified as necessary to provide the specified features and to meet specified operating requirements.

B. Manufacturer of the hydropneumatic tank shall be ISO-9001 certified for designing, manufacturing and testing complete components.

2.02 HYDROPNEUMATIC TANK

A. General:
   1. Pressure vessel shall be made of carbon steel, and fitted with semi-elliptical pressure head. Tank shall be delivered with threaded or flanged bosses for inlet, outlet, and gage/instrument connections.
   2. The interior and exterior of tanks shall be protected with a baked phenolic epoxy coating, factory applied after fabrication. The coating applied in two coats and free of pinholes and thin spots. The factory coating shall be white in color. Field coating of tank exteriors shall be in accordance with Section 00 99 00.

3. Equipment shall meet the requirements of Section VIII, Division 1 of the ASME Boiler Code. Each tank shall bear an ASME inspectors stamp, complete with design working pressure and date and place of manufacturer. All pressure relief valves delivered under this specification shall bear the ASME stamp.
4. The hydropneumatic tank shall connections for pressure relief valve, pressure gages, and connections for water and air shall accommodate the specified equipment and instrumentation.
5. The tank shall be equipped with an ASME pressure relief valve and connections for an inlet/discharge, drain, and others as shown with sizes as indicated on the drawings.
6. The tank shall be provided with a full height protected ASME glass sight gage rated for 350 psig design pressure, and a full height stilling well with connections and isolation valves for level control installation.
7. Provide tank connections for service air, pressure relief valve, air relief valve, vacuum relief valve, sensors, gauges, and sight glasses as required and indicated for the specified equipment and instrumentation.
8. The tank shall be provided with a high pressure gage and a low pressure gage, each with 0-350 psig range and shall be Ashcroft 1479, 4-1/2" with glass window and stainless steel wetted parts.

PART 3 EXECUTION

3.01 INSTALLATION

A. Instrumentation and electrical installation requirements including installation and connection of the equipment shall conform to the Division 26 and 27 specifications.

B. Pressure vessels and tanks shall be aligned, connected and installed at the location shown and in accordance with the manufacturer's shop drawings. Process / electrical / instrumentation connections with the air compressor, tank, and associated controls shall be provided for a fully functioning system. The installation and initial operation of the hydropneumatic tank and air compressor shall be certified by the Supplier.

3.02 FIELD COATING

A. Equipment shall be shop primed prior to shipment from the factory with a primer compatible with the field finish coating as specified in Section 09 99 00. Exterior of tank shall be field coated in accordance with the requirements of Section 09 99 00.

3.03 TESTING

A. Tank shall be hydraulically field testing by filling the tank with water and monitoring the tank as well as all fitting connections for at least 24 hours.

END OF SECTION

SECTION 46 31 11

CHLORINE GAS FEED EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. The chlorination system specified in this section shall be provided by a single supplier or manufacturer.
   2. Provide the provide labor, materials, tools, equipment and services required to furnish, install and test the chlorination system as shown on the Drawings, as specified herein, and as required for a complete functioning system.

B. The chlorine gas feed system shall be a vacuum operated type consisting of:
   1. Two (2) cylinder-mount standard (non-switchover) vacuum regulators for 150 lb cylinders.
   2. One (1) standard (non-switchover) vacuum regulator with drip leg for ton container, to be mounted externally to ton container containment system (chlortainer - see specification 46 31 12).
   3. One (1) automatic switchover module.
   4. Two (2) rotameter panels with a rotometer with 0–20 PPD range. All the necessary appurtenances and valving including that shown on the P&IDs
   5. Two (2) injectors with ¾" inlet/outlet connections
   6. Safety Equipment, Two (2) Self Contained Breathing Apparatuses (SCBAs) with 30 minute air tanks, and SCBA enclosure.
   7. Chlorine Residual Analyzer system.
   8. One (1) Chlorine Gas Leak Detection system.
   9. Necessary vacuum & vent tubing, valves, fittings, and wrenches.

C. The complete system shall have a maximum capacity of 100 pounds per day (PPD) of gaseous chlorine (50 PPD per panel) and sized to feed chorine through two different systems, one upstream of the finished water reservoir and one downstream of the finished water reservoir. Each shall be sized to dose 20.0 PPD of chlorine.

D. System shall be manually controlled having a feed range of 20:1 and the capability to control within ±4% of the indicated feed rate.

E. Cylinder containment equipment is specified in section 46 31 12. 150 lb. Chlorine cylinders shall be supplied by Owner.

1.02 QUALITY ASSURANCE

A. Reference Standards:
   1. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
      a. Recommendations of The Chlorine Institute, Inc.
      b. Occupational Safety and Health Act

c. Joint Industrial Council
d. Instrumentation, Systems, and Automation Society
e. International Building Code – 2023

B. Manufacturer's Qualifications:
1. Equipment shall be the standard product in regular production by manufacturers of chlorination equipment and shall essentially duplicate equipment that has been in satisfactory operation in at least five (5) installations for a period of at least five (5) years.
2. The single supplier or manufacturer of the chlorination system will have to provide certain components, as noted, from other manufacturers in order to meet all the requirements of this Section.

C. Unit Responsibility:
1. The Contractor shall assign unit responsibility as specified in Section 43 05 11-1.02 to the chlorination equipment manufacturer for the equipment specified in this section. A completed and signed Certificate of Unit Responsibility (Form 43 05 11-C, Section 01 99 90) shall be provided.

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00.
1. Shop Drawings
a. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements or those parts which are to be provided by the Contractor or others. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.
b. A copy of the contract document process and instrumentation diagrams I-24-101, I-24-102, and I-24-103, and mechanical layout drawing M-20-203 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required." Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

c. A copy of the contract document electrical drawings E-00-522 and 525 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked “no changes required.” Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

d. Certificate of Unit Responsibility attesting that the Contractor has assigned, and that the manufacturer accepts, unit responsibility in accordance with the requirements of this section and Section 43 05 11-1.02. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.

e. Marked product literature for all the devices and components.

f. Equipment wiring diagrams identifying internal and face mounted components and connections to remote equipment.

g. Shop drawings indicating construction and installation details, a complete detailing of the materials construction and equipment weights.

h. Dimensioned drawings of all equipment an accessories as a complete system including cross-section views.

i. List of spare parts and maintenance items to be provided

B. Informational Submittals

1. Comply with procedures described in Section 01 33 00:
2. Installation Certification Form 43 05 11-A as specified in paragraph 3.02.
3. Training Certification Form 43 05 11-B as specified in paragraph 3.02.

C. Closeout Submittals

1. Comply with procedures described in Section 01 78 23.
2. Provide operating and maintenance submittals as specified in Section 01 78 23.
   a. Include final reviewed shop drawing submittal.
   b. Record of Analyzer configuration settings.
   c. Record of Leak Detector configuration settings.
3. Spare Parts.

PART 2 PRODUCTS

2.01 VACUUM REGULATORS

A. The vacuum regulators shall be rated for 100 PPD of chlorine.

B. They shall be designed to reduce full chlorine gas supply pressure to a vacuum without venting.

C. A self-aligning yoke designed to Chlorine Institute recommendation per drawing 189 shall be provided as an integral part of the vacuum regulators.

D. The units shall include a selector knob and icons to indicate the chlorine gass container status. Each regulator shall include easy to read indication of the following positions:
   1. Operating
   2. Empty
   3. Off

E. An off position shall be provided to isolate the diaphragm and internal components from atmospheric air when the operator changes containers.

F. Vacuum regulators shall contain internal pressure relief capability.

G. Vacuum regulators shall not include automatic switchover capability (non- switchover).

H. The check valve assemblies shall close in the event of leakage past the primary valve.

I. Vacuum regulators shall be Siemens (Wallace and Tiernan) S10K or approved equal.

J. Regulators for 150 lb. cylinders shall be cylinder mounted.

K. Regulator for the ton cylinder shall include drip leg and shall be mounted on the exterior of the chlorine containment vessel. See project drawings.

2.02 AUTOMATIC SWITCHOVER

A. A remote automatic switchover module shall be furnished to change over to new supply as the on-line supply is depleted.

B. Switchover shall be equipped with manual release handle for manual switchover.

C. Switchover shall be non-isolating, such that when the switchover is accomplished gas shall continue to be drawn from the former source until the container is empty.

D. Switchover shall be wall or panel mounted and have easy to read indication for indication of operation status, including indication of which source is active.

E. Switchover shall be Siemens (Wallace and Tiernan) Series 55-410 or pre-approved equal.

2.03 ROTAMETER PANELS

A. Rotameters shall have needle valve type or v-notch type rate control, with manually adjustment capability.

B. Rotameters shall be Siemens (Wallace and Tiernan) S10K or approved equal.

C. Solenoid valves shall be 2-way, direct acting, and shall be suitable for chlorine gas vacuum service. Valves shall be ½-inch and operate at negative pressure and up to 120 degrees F. Unpowered position shall be normally closed. Power requirement shall be 110 VAC.

D. Panels shall include ½" manual schedule 80 PVC ball valves on inlet and outlet of each flow branch as shown on project drawings. Ball valves shall be suitable for chlorine gas vacuum service.

E. Rotameter panels and associated vacuum solenoids shall be pre-assembled and mounted on a ½" thick plastic back panel suitable for wall mounting.

F. The rotameter tubes, solenoid valves and ball valves shall be serviceable without removing the panel upon which they are mounted from the wall.

2.04 INJECTORS

A. The gas feed system shall have two PVC 3/4" fixed throat injectors to generate the operating vacuum for the system.

B. The injector shall be capable of feeding against a backpressure of 15 psi with an operating pressure of 40 PSI, at a flow rate of 4.6 gpm to provide sufficient vacuum to inject up to 20 PPD chlorine gas.

C. Injectors shall include built-in double check valve protection to prevent water from back flooding into the vacuum regulator.

D. A corp stop type injection quill for diffusing the chlorine solution created in the injector into the water piping, as shown in the project drawings shall also be furnished as a part of this system.

E. The injector shall be mounted directly on the injection quill. A section of flexible hose shall be connected to the inlet side of the injector. See project drawings.

F. Injector shall be capable of mounting in either the vertical or horizontal plane.

G. Injector shall be Siemens (Wallace and Tiernan) S10K 3/4" Standard Injector or approved equal.

2.05 SAFETY EQUIPMENT

A. An emergency repair "Kit A" for 150 lb chlorine cylinders shall be supplied.

2.06 SELF CONTAINED BREATHING APPARATUS (SCBA)

A. The SCBA shall be an MSA Workmask, or approved equal, suitable for use with chlorine gas, with 30-minute air tank.

2.07 SCBA ENCLOSURE

A. The wall mounted enclosure for the 30 minute SCBA shall be constructed of fiberglass reinforced plastic (FRP).

2.08 CYLINDER EQUIPMENT

A. One (1) Ton cylinders require secondary containment. A Chlortainer containment system for a one (1) ton cylinder is specified in specification 46 31 12.

2.09 CHLORINE RESIDUAL ANALYZER

A. General:
   1. An on-line chlorine analyzer shall be provided to continuously measure free chlorine residual. Each chlorine monitor shall consist of a direct measuring chlorine sensor, flow cell, sensor interconnect cable with quick disconnect plug, and an electronic monitor housed in a NEMA 4X enclosure suitable for wall, pipe, or panel mounting. Provide for Treated Water and Finished Water. Other analyzers specified with MBR system.
   2. Accuracy: ± 0.02 ppm or 0.5% of full scale. Range 0 – 5.00 ppm.

B. Free Chlorine Monitor:
   1. Chlorine sensor shall be a direct measuring polarographic sensor utilizing a special polymeric membrane to isolate the sensing electrodes from the sample and eliminate the potential for electrode contamination. The membrane shall allow chlorine to diffuse into the sensor where it shall react with the sensing electrode, generating a signal that is linearly proportional to chlorine concentration.
   2. Chlorine sensor shall be constructed with a quick disconnect receptacle to allow easy sensor servicing or exchange. Chlorine sensor shall be furnished for insertion installation. The sensor assembly shall also contain a precision RTD temperature sensor to continuously measure sample temperature to allow temperature compensation of the measured chlorine value.

C. Chlorine Indicating Analyzers:
   1. The chlorine analyzer shall provide an AC powered instrument for operation on 115 VAC single-phase line power. The monitor shall provide two isolated 4-20 mA outputs configurable for chlorine, temperature, pH or PID control. Analog outputs shall be both ground isolated and isolated from each other.
   2. Chlorine analyzers shall also contain two SPDT relays. Relays shall be programmable for either control or alarm function, or relays may be assigned to diagnostic functions for use in indicating trouble conditions at a remote location.
   3. Diagnostic functions shall be incorporated into the transmitter. The 4-20 mA output shall be capable of being assigned to safely rise to 20 mA, fall to 4 mA, or be left alone, during diagnostic failures. Diagnostic error messages shall be displayed in clear language; no confusing error codes shall be displayed.
   4. Provide output hold and output simulate functions to allow for testing or remote receiving devices or to allow maintenance without disturbing control systems.

D. Calibration Tool:
   1. Provide photometer or color disk kit to use in calibration, *Hach CN-66F*, or equal.

2.10 CHLORINE GAS LEAK DETECTOR

A. System Performance Requirements:
   1. The chlorine gas detection system shall measure and display gas concentration and provide alarms when preset limits are exceeded in Chlorine Room. The system shall consist of a NEMA 4X alarm module and a remote mounted gas sensor/transmitter.

2. The gas leak detection system shall meet the following performance requirements:
    a. Power Supply Module Requirements:
        1) Input: 115 VAC, 60 Hertz with battery back-up
        2) Output: Regulated, 13.7 VDC, 1A
    b. Operating Temperature Range: -40° to 55° C.
    c. Relative Humidity Rating: 0-99% non-condensing.
    d. Enclosures (Sensors and Monitor/Transmitter): Corrosion Resistant, NEMA 4X designed for wall mounting, UL approved.
    e. Gas Measuring Ranges:
        1) Standard Range: 0-10 ppm.
    f. Accuracy: ± 5% of reading.
    g. Repeatability: ± 2% of reading.

B. Receiver Module:
1. Receiver module shall provide a high intensity digital LED display of gas concentration, plus alarm indicator LED's for Warning, Alarm, and Trouble. Two programmable alarm setpoints shall be provided for warning personnel of differing levels of leakage. Gas leak alarms shall be indicated by flashing LED indicators on the alarm receiver.
2. The concentration of the gas shall be displayed directly in PPM units. Three alarm relays shall be provided for external alarming functions. Each alarm relay shall be independently assignable to either the low or the high alarm setpoint, and shall also be programmable for latching and/or fail-safe operation.
3. Alarm module shall consist of a NEMA 4X enclosure containing one modular receiver, and one power supply. The enclosure shall contain a hinged window to allow access to controls without tools, and shall be suitable for wall or surface mounting.
4. Each receiver shall provide an isolated 4-20 mA output signal proportional to gas concentration, and shall also contain remote reset input terminals to allow alarm acknowledgment from a remote location.
    a. Alarms: Two adjustable concentration alarms, set point adjustable from 5-100%.
    b. Alarm indication: High Intensity LED Bars for Warning (low setpoint) and Alarm (high setpoint). Indicators shall operate as follows:
        1) Warning level indicator shall be non-latching.
        2) Alarm level indicator shall be latching.
    c. Alarm relays: Three assignable alarm relays.
        1) Functions: Each relay shall be user-assignable for either “alarm” setpoint level (warning or alarm), and shall be configurable for normal/fail-safe, and latching/non-latching, and fast/slow operation.
        2) Contact Rating: 10A at 120 VAC.
    d. Trouble Alarm: Front panel LED indicator and SPDT, factory set for fail- safe operation.
        1) Functions: Indicates loss of sensor/transmitter input or failure of sensor.
        2) Contact Rating: 10A at 120 VAC.

e. Gas Alarm Beacon: Red rotating flashing beacon to indicate gas leak mounted outside the building at the entrance door and a warning sign not enter and to call NTUA when Beacon is flashing – indicating a gas leak.

1) Alarm Panel: Refer to Section 40 67 00.

C. Power Supply

1. The power supply in the receiver module shall be a modular design providing DC power to up to two receiver modules. A third DC output shall be provided to float charge a standby battery system to provide battery backup to the entire detection system in the event of power failure. The power supply shall operate from 115 volts AC, without adjustment, and shall also contain a power failure relay for remote power failure indication.
2. Battery backup module shall be housed in a NEMA 4X enclosure and shall be suitable for operating the detector for at least 4 hours in the event of power outage. Battery backup units shall contain protective circuitry to isolate the battery in the event that battery voltage drops to levels where battery damage might result.

D. Acceptable Product:

1. The chlorine gas detector shall be Siemens (Wallace and Tiernan) or approved equal.

2.11 SPARE PARTS

A. Provide the following spare parts wit the chlorine gas feed system:

1. One (1) spare educator/injector assembly.
2. One (1) spare pressure gauge (for each pressure range).
3. Three (3) spare solenoid valves.
4. One (1) spare rotameter.
5. One (1) complete set of all special tools required for maintenance of chlorine gas leak detection equipment.

B. Provide the following for each chlorine sensor provided with chlorine residual analyzer:

1. Ten (10) spare membranes or one spare complete sensor
2. Electrolyte, if applicable
3. Spare parts kit that includes all o-rings and special hardware

PART 3 EXECUTION

3.01 INSTALLATION

A. The equipment shall be installed per the contract documents and manufacturer's recommendations.

B. Configure the leak detector leak alarm to be fail-safe and closed under normal conditions.

3.02 FIELD SERVICES

A. The equipment shall be checked, aligned, tested, and placed in operation by a factory-trained manufacturer's representative. Installation of the chlorination system shall be certified on Form 43 05 11-A as specified in Section 01 99 90.

B. Calibration:
   1. Provide witnessed calibration of chlorine residual analyzers and associated pH sensors, 4 man-hours on site.
   2. Provide witnessed calibration and test of chlorine leak detector, one man-day onsite.

C. The Contractor shall provide the services of a factory-trained manufacturer's representative to provide training. A minimum two sets of 2 hours of training on operating and maintenance procedures for the chlorination system, detectors, and analyzers shall be provided to plant operations staff. Training shall conform to Section 01 79 00 and shall be certified on Form 43 05 11-B in Section 01 99 90.

D. A factory trained technician shall provide monthly on-site analyzer calibration and chlorinator adjustment service for one year from date of initial service. Service to include calibration materials and reagants. Service to be scheduled in advance with and witnessed by NTUA Operations personnel.

3.03 WARRANTY

A. In addition to the requirements of General Conditions, the equipment/system warranty, unless otherwise stated, shall be one year from start-up or 18 months after shipment.

END OF SECTION

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SECTION 46 31 12

CHLORINE CONTAINMENT SYSTEM AND ACCESSORIES

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. Chlorine containment system for compressed chlorine in two 150 pound cylinders complete with nitrogen gas operated failsafe valve, nitrogen gas supply line to fail-safe actuator, 120 V.A.C. electrical supply line to fail-safe actuator, alarm supply line to fail-safe actuator, scale system with electronic indicator, interior vessel rollers, pressure relief valve, pressure/vacuum gauge and pressure switch, seismic bracing, pressure supply flex hoses (interior), halogenated lubricant, valves, fittings, cylinder loading system (moveable), and manufacturer's on-site consultation services during installation and testing.

B. Design Requirements:

1. Gas containment vessel shall be designed to operate two 150 lb chlorine gas cylinders with vacuum-operated chlorine feed systems. The gas containment system shall provide for a design pressure of 285 psig at 300 degrees Fahrenheit; minimum design metal temperature (MDMT) shall be -20 degrees Fahrenheit at 285 psig; 1/16" corrosion allowance provided; service - chlorine containment.

1.02 SUBMITTALS

A. The following shall be submitted in accordance with Section 01300 and shall include the following information.

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. A copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required." Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

3. Electrical wiring diagrams.
4. Catalog information and detailed drawings as applicable for each component to indicate compliance with specified requirements.
5. Drawings showing all required external connections.
6. List of materials and coatings used.
7. Certification and ASME Code data reports in accordance with the ASME Code and, as applicable, 49 CFR 178.337 or other similar codes. The certification shall include certification of hydrostatic testing.

1.03 QUALITY ASSURANCE

A. Standards:
   1. Components and installation shall comply with the Uniform, Standard and National Building and Fire Codes.
   2. Welding shall be in accordance with ASME Code Section IX using any of the following PPC welding procedures:
      a. SMAW P1-B1
      b. GTAW/SMAW P1-42-1A
      c. SMAW/SAW P1-1A
      d. GTAW P1-1A
      e. FCAW P1-1 ¾ (for non-pressure welds only)
   3. All completed welds shall be visually inspected per inspection procedures QVE-1 Revision 2. Spot radiograph welds per UW-52 of ASME Code Section VIII, Div 1. One increment of weld shall include a junction.
   4. Fabrication shall be in accordance with ASME Code Section VIII, Div. 1. Vessel shall bear a stainless steel ASME nameplate. Nameplate shall bear the applicable code symbols. Manufacturers shall be authorized by ASME to apply the applicable code symbols.

B. Factory Testing:
   1. After fabrication, but prior to application of coating, tank shall be tested in accordance with ASME Code. Tanks shall be hydrostatically tested at the factory to 375 psig per UG99.

C. Unit Responsibility:
   1. The Contractor shall assign unit responsibility as specified in Section 11000 paragraph 1.02.C to the chlorine containment system equipment manufacturer for the equipment specified in this section. A certificate of unit responsibility shall be provided.

1.04 WARRANTY

A. The chlorine gas containment vessel shall be warranted by the manufacturer for full replacement for twelve months from the date of final acceptance.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS:

A. The equipment specified in this section shall be TGO Technologies, Inc. “Chlortainer”, or equal and specified accessories. Weigh scale shall be Force Flow with Wizard 4000 indicator/transmitter, or equal.

2.02 MATERIALS:

Component	Material
Containment vessel	Carbon steel
Door O-ring	Viton
Chlorine valves	
Body	Aluminum silicon bronze Alloy B
Stem	Monel
Interior chlorine transfer hoses	Monel 400 with Type 316 stainless steel cover
Pressure relief valve	
Body	Carbon steel
Trim	Monel
Seat	Teflon
Spring	Inconel X750
Cylinder loading system frame	Carbon steel

2.03 EQUIPMENT FEATURES

A. General:

1. Each container containment system shall consist of a 24-inch diameter containment vessel for two 150 pound chlorine cylinders. The chlorine gas containment system shall be designed to operate with a vacuum-operated solution feed system (provided by others). Containment vessel shall include a nitrogen gas/electrically operated fail-safe valve, nitrogen gas supply and failsafe actuator, 120 VAC electrical connection to failsafe actuator, interior vessel rollers, pressure relief valve, vacuum/pressure gauge, pressure switch, chlorine transfer hose, valves, piping and fitting accessories, weighing system, and manufacturers on-site consultation services. A movable loading system shall be provided.

B. Containment Vessel:

1. Vessel shall be 24-inch diameter. Vessel door design shall be chain drive horizontal double bolt door design closure. Door O-ring shall be provided. Cylinder holding bay within vessel shall be provided with interior rollers, Force Flow Model 21L Roller Trunnions or equal. Bosset connections shall be provided for one primary chlorine gas draw point and one alternative chlorine gas draw point. Ton container valves shall be provided on the exterior for each connection. Ton container valves shall be Sherwood Type 1214 X1-B1, or equal. Two threaded elbow-coupling manual connections shall be welded into interior of vessel. One connection shall be provided for pressure check valve and other connector shall be provided for vacuum/pressure gauge. A ton container valve shall be provided for each elbow coupling connection. Ton container valves shall be Sherwood Type 1214 X1-B1, or equal. A coupling connection into interior of vessel shall be provided for pressure relief valve. All

necessary fittings compatible with chlorine service shall be provided to accomplish connection of valves, switches and gauges to containment vessel.

2. The containment vessel interior shall be sandblasted to SSPC-SP-10 and then coated to 2.5 to 3.0 Mils DFT with Carbonzinc 11 HS (inorganic zinc primer). The vessel exterior shall also be blast cleaned to SSPC-SP-6, then prime coated to 4 to 6 Mils DFT with Ameron 385 Epoxy (Red), or equal. Finish coat exterior with Devoe Coatings Devthane 379 Polyurethane, or equal to 2 Mils DFT. Color BL-6 (OSHA Safety Blue).

C. Interior Transfer Hoses:
   1. Provide two chlorine transfer hoses within interior of containment vessel. Each transfer hose shall be corrugated Monel 400 with stainless steel guard cover.
   2. Each transfer hose shall be gas pressure tested at a minimum of 750 psig.
   3. Each transfer hose shall be ¼ inch inside diameter x 38 inches in length with ¼ in. MNPT ends.
   4. One yoke adaptor #5888-D-1/2-1/4 NPT, one yoke assembly #U1953 ASSY 628, and one ½ x ¼ in.-3000 lb. threaded 90 degree Monel 400 elbow shall be provided for each transfer hose..

D. Vessel Pressure Relief Valve:
   1. Provide one pressure relief valve per containment vessel. Valve shall be connected to containment vessel interior.
   2. Valve size shall be ¾ inch NPT ilnet and 1 FNPT outlet.
   3. Materials for valve shall be as follows: Teflon Seat, Carbon Steel Container, Monel Base, Monel Disc, Monel Insert, Monel Disc Holder, Model Guide and Inconel X750 Steel Spring.
   4. Valve shall be Ferris 900 Omni Trim Vlave Model No. 27CC23-M20/M2 Inconel X750 spring or equal Set to 225 psig.

E. Vessel Vacuum/Pressure Gauge and Switch:
   1. Pressure/vacuum gauge and diaphragm shall be Ashcroft, 3.5 inch dial, 30 inch vacuum, 100 psi pressure range, diaphragm-protected (Viton), ¼ inch threaded with Monel 400 nipple, gauge type #35-1009AW-02L-30/100 or equal, diaphragm type W/25-310UH-02T or equal, Halocarbon fill. Provide appropriate connectors for connection of gauge to vessel interior elbow connector. Pressure switch shall be Mercoid Series A1F or equal, diaphragm-protected, with NEMA 4X enclosure. Diaphragm seal shall have Halocarbon fill.

F. Cylinder Loading System:
   1. Provide one chlorine gas container loader manufactured by TGO, or equal

G. Fail-Safe Valve System:
   1. Fail-Safe actuator and valve system shall consist of an electro-pneumatic actuated ball valve with nitrogen supply system. One fail-safe actuator and valve system shall be provided. One backup manually operated valve system shall be provided.
   2. Fail safe assembly shall include actuator, Swagelok MS-133SR or equal; limit switch, Westlock MS-LSK-L5B, NEMA 4X or equal; and solenoid valve, Swagelok M63-TSW8P-HC-33CJ-LB5/120V EF8320G714/120V or equal. Ball valve shall be Swagelok M63TSW8P-HC or equal, ½ inch, Monel body, Hastalloy ball, Teflon seats, chlorine cleaned.

3. Backup manual valve shall be ½ inch, Monel body, Hastalloy ball, Teflon seats, chlorine cleaned. Nitrogen system for pneumatic operation of fail-safe valve system shall include one 55 cubic foot capacity high pressure nitrogen gas cylinder with a supporting stand; one pressure regulator, Harris 2500-580 or equal, and one pigtail assembly of ¼ inch-1500 psi, 72 inch long Teflon tube with braided stainless steel covering, with one safety relief valve.

H. Chlorine Weight Scales:
   1. One weigh scale shall be provided for the containment vessel, sized and designed for the containment system and associated gas cylinders. The chlorine weighing scale system shall be within the dimensions of the equipment it supports. A single digital readout and transmitter system shall be provided. Digital readout shall be of the dual display type and shall have the capability to display net, gross, and tare values. Readout shall be equipped with a digital keyboard for easy entry of tare values. The weight indicator shall be provided with a weight transmitter 4-20 mA DC for remote signal transmission of scale contents (chlorine weight).

I. Chlorine Pressure Switch:
   1. Pressure switch shall be connected to the pressure/vacuum gauge.
   2. Pressure switch shall be Mercoid Pressure Switch Model A1F-0SS-1-2, 4-75 psi with Nema 4X enclosure. Diaphragm Seal Model EWX247CTN with Halocarbon fill. Set at 5psi rising or equal

2.04 PAINTING

A. Vessel painting shall be as specified herein. If any damage to the paint system occurs, the equipment shall be repainted as directed by the OWNER.

2.05 ANCHOR BOLTS

A. Anchor bolts and nuts shall be of ample size and strength for the purpose intended and sized by the equipment manufacturer, using methods designed to transfer the full, ultimate strength of the anchor bolt to the concrete foundation. See TGO Technologies, Inc installation instructions for size recommendations. Anchor bolts shall be supplied and installed by Contractor. Installation shall be per Manufacturer's instructions.

2.06 SPARE PARTS AND ACCESSORIES

A. The following spare parts shall be furnished:
   1. One (1) Viton 0-ring for 24-inch closure
   2. Two (2) 24" Chlorine Feed LInes
   3. Two (2) Yokes
   4. Two (2) Yoke Adapters
   5. Two (2) Twisted Chlorine Wrenches
   6. Two (2) Whitey Hastalloy Balls
   7. Two (2) Whitey Ball Valve Repacking Kits
   8. Six (6) vessel closure locking nut gaskets
   9. One (1) Halocarbon Grease 1 lb. Rust Inhibitor
   10. One (1) Complete Vacuum/Pressure Gauge Assembly

11. Two (2) Nitrogen Safety Relief valve
12. One (1) 55-lb Nitrogen Container filled

2.07 PRODUCT DATA

A. The following information shall be submitted in accordance with Section 01 30 00:
   1. Installation instructions.
   2. Dimensional drawings as required for installation, including clearance requirements.
   3. Operations and maintenance information specified in Section 01 78 23.
   4. Installation Certification Form 11000-A as specified in paragraph 01 99 90.
   5. Training Certification Form 11000-B as specified in paragraph 01 99 90.

PART 3 EXECUTION

3.01 INSTALLATION AND TESTING

A. The Contractor shall install and test the equipment in strict conformance with the manufacturer's recommendations. Vacuum regulators (by others) shall be connected to the supply valve on the containment vessel. The equipment shall be checked, tested, and placed in operation by a factory-trained manufacturer's representative. The representative shall provide a minimum of 2 full (8 hr) days of service to fulfill the requirements of this paragraph and those specified in paragraph 01 78 23. Installation of the chlorine containment system shall be certified on Form 01 45 20-A as specified in Section 01 99 90. Installation, testing, and commissioning shall be carried out in accordance with Sections 01 66 00. Unless otherwise specified, equipment unit shall be anchored to structural systems and shall resist all forces incidental to equipment operation.

3.02 START-UP

A. Cleaning:
   1. All parts of equipment or piping that may come in contact with chlorine shall be free of oil or grease before being put into service. Valves shall be dismantled, thoroughly cleaned with suitable solvents, and repacked if necessary. Any pipe dope inside the pipe shall be removed and oil or grease shall be removed with suitable solvent. The interior of all piping and valves shall be clean and thoroughly dry.

B. Initial Operation:
   1. Chlorine gas shall be admitted to the system only after the installation of all equipment is completed and the system has been tested and thoroughly checked for leaks. Training: The Contractor shall provide the services of a factory-trained manufacturer's representative to provide training. A minimum of 2 hours of training on operating and maintenance procedures for the chlorine containment system shall be provided to plant operations staff.

END OF SECTION

SECTION 46 33 42.13

MECHANICALLY-ACTUATED DIAPHRAGM-TYPE METERING PUMPS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. The section specifies positive displacement, mechanically actuated, non-lost motion diaphragm metering pumps and associated appurtenances for chemical feed service in water and wastewater treatment applications.

B. Type:

1. Metering pumps shall be of the positive displacement, mechanically-actuated, non lost motion diaphragm type driven by electric motors. Pumps shall provide an amplitude modulation (non-loss motion) stroke adjustment mechanism producing sinusoidal flow output at all stroke length settings. Pumps shall be driven by variable speed AC which actuate a composite disc diaphragm to produce liquid pumping. Pump output shall be rated at design operating temperature and be adjustable while the pump is operating. Pumps shall be simplex design unless otherwise specified. The Contractor shall furnish and install complete chemical metering systems with associated pump supports, controls, appurtenances and miscellaneous equipment to provide an operating installation as shown or otherwise specified. The pump shall be suitable for the intended metering service with adjustable speed controls as required to provide the degree of dosing control described herein. Metering pumps shall be fully water proof and suitable for installation outdoors or in wet processing areas.

C. Equipment List:

Equipment Description	Equipment Number
Sodium Hypochlorite Pump 1	P2260
Sodium Hypochlorite Pump 2	P2261
Citric Acid Pump 1	P2262
Citric Acid Pump 2	P2263
Sodium Bisulfite Pump 1	P2264
Sodium Bisulfite Pump 2	P2265
Sulfuric Acid Pump 1	P2266
Sulfuric Acid Pump 2	P2267
Sodium Hydroxide Pump 1	P2268
Sodium Hydroxide Pump 2	P2269
Backwash Coagulant Pump 1	P2510
Backwash Coagulant Pump 2	P2520

D. Performance and Design Requirements:

1. Operating Requirements:

a. The metering pump(s) shall be designed for continuous service under the following design and operating conditions.

Equipment Number(s)	P2260, P2261	
Parameter	**Design Value**	**Units**
Chemical	Sodium Hypochlorite, 12.5%	
Maximum chemical feed rate	1.07	gpm
Operating pressure	40	psi
Maximum Static Lift	6	ft
Power supply	120/60/1	V/Hz/phase

Equipment Number(s)	P2262, P2263	
Parameter	**Design Value**	**Units**
Chemical	Citric Acid, 50%	
Maximum chemical feed rate	0.82	gpm
Operating pressure	40	psi
Maximum Static Lift	6	ft
Power supply	120/60/1	V/Hz/Phase

Equipment Number(s)	P2264, P2265	
Parameter	**Design Value**	**Units**
Chemical	Sodium Bisulfite, 38.0%	
Maximum chemical feed rate	0.25	gpm
Operating pressure	40	psi
Maximum Static Lift	6	ft
Power supply	120/60/1	V/Hz/Phase

Equipment Number(s)	P2266, P2267	
Parameter	**Design Value**	**Units**
Chemical	Sulfuric Acid, 50.0%	
Maximum chemical feed rate	0.29	gpm
Operating pressure	40	psi
Maximum Static Lift	6	ft
Power supply	120/60/1	V/Hz/Phase

Equipment Number(s)	P2268, P2269	
Parameter	**Design Value**	**Units**
Chemical	Sodium Hydroxide, 25.0%	
Chemical feed rate	0.45	gpm
Operating pressure	40	psi
Maximum Static Lift	6	ft
Power supply	120/60/1	V/Hz/Phase

Equipment Number(s)	P2610, P2610	
Parameter	**Design Value**	**Units**
Chemical	TBD	
Chemical feed rate	1.0	gpm
Operating pressure	40	psi
Maximum Static Lift	6	ft
Power supply	120/60/1	V/Hz/Phase

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM A743/A743M-88	Castings, Iron-Chromium, Iron-Chromium-Nickel, and Nickel-Base Corrosion-Resistant for General Application
NEMA MG 1	Motors and Generators
NEMA ICS 1	Industrial Control and Systems General Requirements

B. Unit Responsibility:

1. Assign unit responsibility, as specified in Section 43 05 11, to the metering pump manufacturer for the pumps, accessory components, mounting panels and control systems specified in this Section and associated Process and Instrumentation drawings unless provided as part of an equipment package. Provide a completed and signed certificate of unit responsibility (Section 01 99 90-Form 43 05 11-C). In the cases where the equipment is supplied as part of an equipment package (such as the equipment provided as part of Section 46 61 33), unit responsibility shall be assigned to the manufacturer of the equipment package.

1.03 SUBMITTALS

A. The following submittals shall be provided as specified in Section 01 33 00.

B. Action Submittals – Shop Drawings:

1. Shop drawings with complete dimensions and mounting details for the pumps and all appurtenances.
2. Catalog data and information including:
   a. Maximum and minimum capacity using adjustable speed drive, gpm; maximum and minimum operating speed, rpm; and discharge pressure.
   b. Motor information.
3. Materials of construction.
4. Net positive suction head required.

5. Manufacturer's wiring diagram.
6. Manufacturer's catalog data on all accessories including pressure regulating valves, pressure relief valves, chemical seals, pressure gauges, calibration chambers, pulsation dampeners, and suction assemblies.
7. A copy of the contract document control diagrams E-00-514 and E-00-515, and process and instrumentation diagrams I-22-111, I-22-112, 1I-22-113, I-22-114, and I-22-115 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
8. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined shall signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
9. A copy of all related contract schematic, structural, and mechanical drawings with all piping, foundations, supports, and layout sizes and dimensions requiring Contractor confirmation marked.
10. Certificate of Unit Responsibility attesting that the Contractor has assigned, and that the manufacturer accepts, unit responsibility in accordance with the requirements of this Section and Section 43 05 11-1.02 Unit Responsibility. No other submittal material will be reviewed until the certificate has been received and found to be in accordance with these requirements.

C. Closeout Submittals:
   1. Comply with procedures described in Section 01 78 23.
   2. Provide operating and maintenance submittals as specified in Section 01 78 23. Include final reviewed shop drawing submittal.
   3. Spare Parts.

1.04 MANUFACTURER'S REPRESENTATIVE

A. Field services shall be performed by qualified personnel with at least five (5) years experience providing field services for similar equipment installation for System Supplier.

PART 2 PRODUCTS

2.01 GENERAL

A. The manufacturer shall furnish all metering pump equipment to complete a properly functioning, integrated package. Unless otherwise specified, the metering pump system shall be factory assembled to the maximum extent possible. Factory assembly shall include all pumps, motors, bases, and appurtenant valves and fittings. Any components that are not factory assembled shall be shipped loose and packaged and labeled with complete instructions for field installation. No field welded shall be required.

B. The metering pump assembly shall be designed by the manufacturer or supplier to provide the necessary strength, stability, and stiffness for the intended application conditions. Equipment, piping, valves and controls shall be rigidly and accurately anchored to a support structure in the proper position and arrangement and to optimize access for maintenance. The support structure and mounting hardware shall be compatible with the chemicals being metered (corrosion-resistant), and shall be non-metallic unless otherwise specified.

2.02 ACCEPTABLE PRODUCTS

A. The following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. The manufacturer's standard product may require modification to conform to specified requirements:
   1. Siemens/Wallace & Tiernan Encore 700 Series.
   2. Milton Roy MacRoy Series,
   3. ProMinent Sigma Series.
   4. Approved equal.

2.03 METERING PUMPS

A. Mechanically-actuated metering pumps furnished under this Section shall be non-lost motion diaphragm pumps employing an amplitude modulation stroke adjustment mechanism to produce a smooth sinusoidal output at all stroke length settings. The pumps shall be driven by a variable speed AC motor to actuate disc diaphragm. The pumps shall be pulley coupled. When the pulley and belt mechanism is combined with variable DC drive, total turndown shall be 800:1.

B. The liquid end shall be designed to provide easy access for maintenance and integral sight flow indication. Check valves shall be double ball cartridge type manufactured of CPVC. Valve retainers shall be clear CPVC and shall compression seal to the pump head and pipe connectors using o-rings. Valves shall be easily serviced without impacting the remainder of the pump head. The diaphragm shall be Teflon-faced, fabric reinforced and bonded to preformed elastomeric support. It shall incorporate convolutions for unconstrained rolling action and a steel backer plate for volumetric accuracy. An o-ring groove shall be provided in the pump heads diaphragm cavity to achieve a leak free seal. A secondary diaphragm shall be provided to completely seal and separate the pump head from the drive unit and eliminate the possibility of contamination of the gearbox lubricant with process fluid.

C. The stroke adjustment mechanism shall be steel and nodular iron housed in an epoxy-coated, cast iron gearbox. All drive bearings shall be tapered rollers and fasteners shall be stainless steel. The gearbox shall be oil-bath lubricated. Stoke length shall be controlled manually with a 10-turn micrometer with vernier indication of stroke length in 0.25 percent increments. Feed rate shall be infinitely adjustable from 0 through 100 percent with each revolution of the knob changing stroke length by 10 percent. Repeatable metering accuracy of +/- 2 percent of full scale is required at constant hydraulic conditions.

2.04 PUMP CONTROLS

A. Each pump shall be controllable based on a compound input signal from the Membrane LCP to the pump control unit. Stroke frequency shall be controlled automatically by speed control of the variable speed DC pump motor.

B. The integral pump controller shall have a membrane touch key pad, LED bar graph of percent pump speed and a 16 character alphanumeric LCD display of all operating and set up parameters. The control panel shall allow the operator to select one of the following control modes;
   1. Remote control of stroke speed.
   2. Manual control of stroke speed.

C. The controller shall provide run status and an alarm dry-contact outputs. The pump controller shall be housed in a NEMA 4X enclosure and be powered by 115 VAC supply.

D. Each metering pump head shall be provided with a diaphragm leak detection system to detect early stages of diaphragm failure. The leak detection system shall consist of a solid state electro-optic sensor mounted in the liquid end of the pump and a NEMA 4X control box. Each control box shall be capable of monitoring two liquid pump ends and shall have both local and remote failure indication.

2.05 ACCESSORIES

A. The following accessories shall be provided by the manufacturer having unit responsibility:
   1. Pulsation Dampeners:
      a. Pulsation dampeners shall be provided on the discharge piping of each pump as shown. Pulsation dampeners shall be of plastic construction and be of the single diaphragm type, consisting of a pressurized vessel containing a flexible elastomer diaphragm separating pressurized gas in the upper zone from process fluid in the lower zone. Pulsation dampeners shall be sized to limit discharge pressure variation to 5 percent or less. The minimum gas volume in the dampener shall be at least 15 times the maximum pump stroke volume. Dampener housing wetted components and diaphragm materials shall be compatible with the chemical service. Each dampener shall be clearly labeled with its intended chemical and pressure service. Pulsation dampeners shall be equipped with a high quality, glycerin-filled, stainless steel pressure gauge in the upper chamber with a minimum 2-1/2-inch dial graduated to 150 psi and a gas fill valve with cap.

2. Calibration Columns:
    a. Calibration columns shall be furnished where shown and shall be of clear PVC construction, graduated in millimeters. Columns shall be at least 1 liter in size unless otherwise specified or shown.
3. Back Pressure Valves:
    a. Backpressure valve shall apply a continuous discharge back pressure downstream of the metering pumps and also serve as anti-siphoning valves. Backpressure valves shall be non-metallic and suitable for the pumped liquid characteristics. Backpressure valves shall meet the requirements outlined in Section 40 05 67.33
4. Chemical Seals and Pressure Gauges:
    a. Chemical seal assemblies and pressure gauges shall be provided, refer to Section 40 06 70.

2.06 SPARE PARTS AND SPECIAL TOOLS

A. Spare parts and special tools required for maintenance of the pumps and accessory items shall be provided. One complete set of necessary spare parts, as recommended by the manufacturer, including seals, diaphragms, check valve assemblies, valve seats, and other parts subject to wear, for each pump.

PART 3 EXECUTION

3.01 GENERAL

A. Pumps shall be aligned, connected, and installed in strict accordance with the manufacturer's instructions.

3.02 INSTALLATION

A. The equipment shall be installed and tested under the direction of factory trained personnel as specified in Section 43 05 11. The installation shall be certified on Form 43 05 11-A specified in Section 01 99 90.

3.03 TESTING

A. After installation, the equipment specified in this section shall be completely tested to ensure compliance with operating requirements, varying pumps speeds with speeds and flows recorded in a test log. Pump systems shall initially be tested with clean water and then the chemical to be pumped. Field testing shall be in accordance with the testing procedures in Section 01 45 20. Testing shall verify the control strategies specified in Division 40.

B. Following successful testing and commissioning of associated control loops, and prior to pumping chemical solution, the pump and chemical piping shall be emptied and dried.

3.04 TRAINING

A. Training, as specified in Section 01 79 00, shall be provided. Training shall be certified on Form 43 05 11-B specified in Section 01 99 90.

1. Shipment, Protection and Storage:

   a. The equipment specified in this section shall be protected during shipment and storage as specified in Section 01 66 00.

2. Warranty:

   a. The equipment specified in this section shall be warranted for not less than 12 months following acceptance of the tested installation by the Owner.

END OF SECTION

SECTION 46 33 44

PERISTALTIC METERING PUMPS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section specifies pumps and accessories for feeding sodium hydroxide for the purpose of effluent disinfection and membrane maintenance and recovery cleaning.

B. Type:

1. The metering pumps shall be of positive displacement, peristaltic type utilizing a flexible tube and spring loaded roller or track. The pump shall be suitable for metering service with adjustable speed drives to control the dosage with accuracy of one percent variation from the pump setting. Each pumping unit shall be complete with pump, drive unit, base, and all appurtenances to provide a complete pumping system for the specific process fluids and design characteristics as specified herein.

C. Equipment List:

Equipment Description	Equipment Number
Sodium Hydroxide Pump 1	P2510
Sodium Hydroxide Pump 2	P2520

A. Performance and Design Requirements:

1. General:

a. The metering pumps and equipment shall be designed and selected for pumping the following chemical solution:

Chemical	Solution Density[1]	Concentration (wt/wt)
Sodium Hydroxide	3.2	25.0%

[1] Solution density, lb per gal @ 68 degrees F

b. Pump operation shall be automatic. Adjustable speed drives shall be controlled by a 4-20 mA signal.

2. Design Requirements:

a. The metering pumps shall be designed for continuous duty under the following operating conditions:

Equipment Numbers	P2510, P2520	
Parameter	**Design Value**	**Units**
Minimum chemical feed rate	.9	gpd
Average chemical feed rate	4.5	gpd
Maximum chemical feed rate	13.2	gpd
Operating pressure	15	psi
Maximum discharge pressure	85	psi
Maximum power consumption	135 VA	hp or VA

Equipment Numbers	P2510, P2520	
Parameter	Design Value	Units
Maximum rotor speed	200	rpm
Power supply	120/60/1	V/Hz/phase]

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM A743/A743M-88	Castings, Iron-Chromium, Iron-Chromium-Nickel, and Nickel-Base Corrosion-Resistant for General Application
NEMA MG 1	Motors and Generators
NEMA ICS 1	Industrial Control and Systems General Requirements

1.03 ENVIRONMENTAL CONDITIONS:

A. The equipment shall be located indoors in heated and ventilated areas. Environmental conditions are as described in Section 01 11 80.

1.04 SUBMITTALS

A. The following submittals shall be provided as specified in Section 01 33 00.

B. Action Submittals – Shop Drawings:

1. Shop drawings with complete dimensions and mounting details for the pumps.
2. Catalog data and information including:
   a. Maximum and minimum capacity using adjustable speed drive, gpm; maximum and minimum operating speed, rpm; and discharge pressure.
   b. Motor and adjustable speed drive type.
3. Materials of construction.
4. Net positive suction head required.
5. Manufacturer's wiring diagram.

6. Manufacturer's catalog data on all accessories including pressure regulating valves, pressure relief valves, flow calibration chambers, and suction assemblies.
7. A copy of the contract document process and instrumentation diagram I-25-101 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
8. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
9. A copy of all related contract structural, and mechanical drawings with all piping, foundations, supports, and layout sizes and dimensions requiring Contractor confirmation marked.

C. Informational Submittals
   1. Comply with procedures described in Section 01 33 00:
      a. Installation Certification Form 43 05 11-A as specified in paragraph 3.01.
      b. Submit Training Certification Form 43 05 11-B as specified in paragraph 3.04.

D. Closeout Submittals
   1. Comply with procedures described in Section 01 78 23.
      a. Provide operating and maintenance submittals as specified in Section 01 78 23.
         1) Include final reviewed shop drawing submittal.
      b. Spare Parts.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Owner and Construction Manager believe the following candidate manufacturer is capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer’s product, nor shall it be construed that a named manufacturer’s standard product will comply with the requirements of this Section. Candidate manufacturers include Watson Marlow, or equal. The Owner and Construction Manager are not aware of an equal manufacturer.

2.02 GENERAL

A. The manufacturer shall furnish all meter pump system equipment to complete a properly functioning, integrated package as intended by these specifications. The system shall be factory-assembled to the maximum extent practical. Factory assembly shall include all pumps, motors, bases, drives, and appurtenant valves and fittings. Any component parts not pre-assembled due to packaging and shipping concerns shall be identified and clearly labeled. No field welding will be allowed.

B. All materials used for the metering pumps and accessories shall be designed by the manufacturer to have the necessary strength, stability and stiffness for the intended service. All connections, foundation bolts, plates, nuts, washers and clamps shall be corrosion resistant to the conditions of use.

2.03 MATERIALS

A. The peristaltic metering pumps shall be manufactured of the following materials:

Equipment Number	P2510, P2520
Case	Die-cast aluminum
Track	Polyphenylene sulfide
Rollers	316 stainless steel
Bearings	316 stainless steel with PTFE seals
Drive shaft	Nickel plated steel

B. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose

2.04 EQUIPMENT

A. Pump and Drive Mechanism:

1. Pump shall be of the positive displacement peristaltic type utilizing a flexible tube. The tubing shall be in contact with the inside diameter of the track (housing) and be held in place on the suction and discharge by a hand adjustable clamp mechanism. Tube clamps requiring tools are not acceptable. Suction and discharge shall be on the same side of the pump head. The tubing shall be replaceable with no disassembly of the pump head and without the use of tools. Each pump shall consist of track/pump head cover with safety lock-out switch, screw down retainer mechanism, roller rotor assembly with integral adjustable speed drive. The lock-out switch shall render the drive inoperable when opened. The pump head shall be easily secured to the drive and be self locating.
2. Each pump shall be capable of self priming when completely dry with a suction lift capability of up to 30 feet of water. The pump shall be capable of running dry without damaging effects to the pump or tubing. The pump shall require no check valves or diaphragms and shall not require any dynamic seals in contact with the process fluid. The process fluid shall only be in contact with the inside of the pump tubing.

3. Pumps shall be configured to conform with space constraints as shown in the Contract Drawings.

B. Tubing:
   1. The manufacturer shall furnish the appropriate hose material for the conditions of use (e.g., extruded Marprene, Neoprene, Silicone, PVC, or Viton). The tubing shall be of 64 shore A durometer.
   2. Pump tubing diameter may vary for different drive sizes. For drive speeds ranging from 10 to 360 rpm, the pump must accept tubing with a wall thickness of 3/16 inch and an inside diameter ranging from of 3/4 inch to 1 inch. For drive speeds ranging from 5 to 265 rpm, the pump must accept a wall thickness of 1/8 inch and a variation in inside diameter ranging from 1/2 inch to 5/8 inch. For drive speeds ranging from 10 to 220 rpm, the pump must accept tubing with an inside diameter of 1/8 inch.

C. Rotor Assembly and Track:
   1. The rotor assembly shall be equipped with two or four self lubricating geared compression rollers mounted on spring loaded arms. Rotor material of construction shall be as specified in paragraph 2.03 Materials. Compression rollers shall be symmetrical about the rotor for compression of the hose against the track. The track material shall be as specified in paragraph 2.03 Materials, and if cast aluminum; shall be factory coated with trimite polyurethane. One roller shall at all times be fully engaged with the tubing providing complete compression to prevent back flow or siphoning. The pumping action shall be created by the occlusion of the pump hose and its subsequent restitution causing a vacuum effect to draw the fluid into the suction side of the hose. Hose occlusion shall be adjustable with a lead screw, which limits the travel of the spring, loaded roller.

D. Piping Connection:
   1. Adapters and connective fittings between the flexible tubing and the fixed piping shown on the Contract Drawings shall be provided by the manufacturer for each size tubing that is compatible with each pump.

E. Valves
   1. Adjustable diaphragm backpressure regulating type valves shall be installed on pump discharge as shown on the drawings. Pressure shall be set according to the table below. Valve shall be suitable for the chemical solution service specified. The valve meet the requirements of Section 40 05 67.33.

Valve number	Service	Valve size, inches	Maximum flow, gpd	Inlet pressure range, psig	Outlet pressure, psig
BPRV2510A	SHX	1/2	13.2	40	5
BPRV2520A	SHX	1/2	13.2	40	5

   2. Adjustable pressure relief type valves shall be installed on pump discharge as shown the drawings. Pressure shall be set according to the table below. The valves shall be sized to handle a maximum flow through the valves of not less than 1.5 times the maximum flow supplied by the associated pump. The valve shall be suitable for the chemical solution service specified. The valve meet the requirements of Section 40 05 67.36.

Valve number	Service	Valve size, inches	Pressure Relief, psig
PRV2510A	SHX	3/4	45
PRV2520A	SHX	3/4	45

2.05 DRIVE UNITS AND CONTROLS

A. Adjustable Speed Drive:
   1. Pumps shall be provided with an integrally mounted adjustable speed drive. The speed setting of the drive shall be continuously adjustable over a minimum 110:1 operating range. The adjustable speed drive shall be for use with brush motors, and be located in a NEMA 4X cabinet. Drive shall be supplied with one 120 VAC input. Drive motor shall be servo permanent magnet DC with integral gear box.

B. Motors:
   1. Drive shall be rated for continuous 24-hour operation. Pumps shall have non-maintained maximum speed switches for purpose of priming. Pump drives shall be close coupled and self aligning, requiring no flexible couplings. Each pump shall be capable of operating with a range of hose/tubing diameters and thicknesses which may vary depending on the drive size of the pump.
   2. The drive enclosure shall be NEMA 4X rated and be factory coated with a corrosion resistant non-reactive (e.g. polyester and/or polyurethane) coating. Drive motors shall be integrally mounted in drive enclosure.

C. Control Panel:
   1. Local controls shall consist of a speed adjusting potentiometer and an AUTO/MANUAL switch. Control shall be such that when the drive is running in the MANUAL mode, speed shall be adjusted with the local potentiometer. In the AUTO mode, the drive shall operate in response to a external run command and 4-20 mA external speed reference signal as shown on drawings.
   2. NEMA 4X rated controls shall be provided on the pumps. The controls shall provide as a minimum the following features:
      a. Accept a 4-20 mA speed reference input signal
      b. Accept dry REMOTE-RUN contact
      c. Provide dry contacts rated for 1 amp at 120 V AC for the following status:
         1) Running
         2) Pump leaking

2.06 EQUIPMENT MOUNTING

A. Pumps shall be suitable for installation on a wall-mounted structural support.

2.07 ACCESSORIES

A. Flow Calibration Columns:
   1. Pumps shall be provided with flow calibration columns on the pump suction lines. Calibration columns shall be manufactured of clear PVC, and shall be labeled in standard divisions and milliliters. Calibration columns shall have a volume of 1/2 liter and shall have 1/2-inch female NPT connections at the top and bottom. Calibration chambers shall be provided by the same manufacturer as is furnishing the pumps.

B. Leak Detection:
   1. Pumps shall be provided with leak detection located on the tube which shall interconnect to the pump control panel. The control panel shall provide a dry contact alarm for remote indication of leak detection.

2.08 COATINGS

A. Except as otherwise specified in this Section 46 33 44, equipment shall be shop primed in accordance with the requirements of Section 09 90 00.

2.09 SPARE PARTS

A. The following spare parts components shall be provided:
   1. Ten lengths of tubing in each size (diameter) as necessary to satisfy the requirements of paragraph 1.01 Design Requirements.
   2. One pump head for each size pump.

B. Spare parts shall be tagged and stored as specified in Section 43 05 11.

PART 3 EXECUTION

3.01 GENERAL

A. Pumps shall be aligned, connected, and installed in strict accordance with the manufacturer's instructions.

3.02 INSTALLATION

A. The equipment shall be installed and tested under the direction of factory trained personnel as specified in Section 43 05 11. The installation shall be certified on Form 43 05 11-A specified in Section 01 99 90.

3.03 TESTING

A. After installation, the equipment specified in this section shall be completely tested to ensure compliance with operating requirements, varying pumps speeds with speeds and flows recorded in a test log. Field testing shall be in accordance with the testing procedures in Section 01 45 20. Testing shall verify the control strategies specified in Division 40.

B. Following successful testing and commissioning of associated control loops, and prior to pumping chemical solution, the pump and chemical piping shall be emptied and dried. See Section 40 05 01 for additional requirements.

3.04 TRAINING

A. A minimum of 6 hours of training, as specified in Section 01 79 00, shall be provided. Training shall be certified on Form 43 05 11-B specified in Section 01 99 90.

END OF SECTION

SECTION 46 41 17

INLINE STATIC MIXERS AND INJECTORS

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies the general requirements for design, selection, and supply of inline static mixers. Installation, inspection, and testing are also specified in this Section.

B. Equipment List

Item	Equipment Number
Static Mixer 1	SMX3011
Sodium Hypochlorite Injection Quill 1	INJ2260
Citric Acid Injection Quill 1	INJ2262
Sodium Bisulfite Injection Quill 1	INJ2264
Sulfuric Acid Injection Quill 1	INJ2266
Sodium Hydroxide Injection Quill 1	INJ2268
Chlorine Injection Quill 1	INJ2410
Chlorine Injection Quill 2	INJ2420
Sodium Hydroxide Injection Quill 2	INJ2510
Backwash Coagulant Injection Quill 1	INJ2610

1.02 RELATED SECTIONS

A. Section 01 33 00 – Submittal Procedures

B. Section 01 60 00 – Product Requirements

C. Section 40 05 02 – Piping System Schedules

D. Section 40 05 45 – Piping System Identification

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

Reference	Title
ASME B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
ASME B31.1	Power Piping
ASME B31.3	Process Piping

1.04 SUBMITTALS

A. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The City shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

B. Submit a shop drawing showing the material of construction, sizing, dimensions, and connection types for the inline static mixers.

C. Submit calculations showing the sizing and performance details (mixing efficiency)

D. Submit installation, operation, and maintence manuals.

1.05 QUALITY ASSURANCE

A. Review the drawings prior to installation of equipment. Coordinate the length of the mixers with availbale space for installation.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 60 00 for shipment and storage.

PART 2 PRODUCTS

2.01 MIXERS

A. Type:
   1. The inline mixers shall be of static or motionless type that consist of a series of fixed elements placed at the right angles to each other and enclosed in a tubular housing designed for pipeline installation. The mixers shall have no moving parts. Where listed, mixers shall be wafer type.

B. Manufacturers:
   1. Manufacturers: Candidate manufacturers are listed below. The manufacturer's standard product may require modification to conform to specified requirements:
      a. Komax
      b. Statiflow
      c. Westfall
      d. Or Approved Equal

C. Performance and Design Requirements:

1. The spool mixers shall thoroughly mix the chemicals injected onto the mixer to achieve a minimum mixing effliciency (COP) of 95% at the immediate outlet of each mixer without exceeding the allowable headloss. The water and chemical flow rates and chemical details are provided in the table below:
2. The wafer mixers shall provide uniform mixing of the injected chemicals with water, with a mixing efficiency of 99% (CoV 0.01) within 10 pipe diameters downstream of the mixer at flow rates shown in the table below. Submit headloss curves for the static mixer, which must show the static mixer complies with the requirements in the mixer table.

Equipment Number	Mixer Size	Water Flowrate		Chemical Details			Maximum Allowable Headloss	Mixer Type	Mixer Material
		Max	Min	Chemical	Maximum Flowrate	Minimum Flowrate			
SMX3011	10 in	1000 gpm	250 gpm	CLS (INJ2420)	17.2 gpm	17.2 gpm	2.5 ft	Spool or Wafer	316 SS
				SHX (INJ2510)	6.6 gpd	0.2 gpd			

3. Spool Mixers:
   a. The mixers shall be provided with Class 150 flanges.
   b. Mixer housing and elements shall be made of materials shown on the table above.
   c. The mixers shall not have any pre-requisite on upstream and downstream lengths for meeting the performance requirements.
   d. Each mixer shall be provided with a pipe extension and injection quills to facilitate injection of the chemicals. The injection quills shall be provided with an isolation valve to facilitate the withdrawal of the quill without shutting down the mixer.
   e. The mixers will be installed in an indoor location and shall be suitable for the installed location.
4. Wafer Mixers:
   a. Mixers shall be wafer type with a compact ring body design for mounting between two standard ANSI 150-lb pipe flanges.
   b. Provide ring type gaskets to adhere to both sides of the mixer body. The mixer plates shall be designed to create mixing vortices to effectively mix the injected chemicals with the process water.
   c. The static mixer shall include chemical injection ports. See Drawings for the size and number of injection ports for the mixer and coordinate size with the injector furnished. The mixer lay length shall not exceed 3.5 inches.
5. The static mixer and gasket materials of construction shall be as listed in table above. Coatings to ensure chemical compatibility of the mixer housing and mixing elements with the injected chemical shall not be accepted. The static mixer shall be NSF/ANSI 61 certified.

2.02 INJECTION ASSEMBLIES:

A. Provide injection assemblies where shown on the Drawings and specified herein.

B. Requirements:

1. Injection quills shall be threaded into the side of the process pipe or mixer at the locations specified with 1/2-in or 3/4-in NPT fitting.
2. Components shall include a spring-loaded ball check valve, retractable solution tube (injector), solution tube body, compression gland, ball valve, dual limit chains and dual bolt restraints.
3. Tip profile of the injection tube shall be standard/flat except for SBS and NaOH quills which shall include elastomeric duckbill tips.
4. Coordinate injector tube insertion length with the static mixer manufacturer where applicable to insure against interferences with the mixer port and/or mixing plate and to insure the chemical is injected in the centerline of the process pipe.
5. Injection quills shall be installed at each location identified in the table below, and shall be constructed with materials compatible with each chemical. Injection quills shall be able to withstand maximum pump discharge line pressure and water main pressure.
6. Injection assemblies shall be as manufactured by Saf-T-Flo or equal.

Equipment Number	Main Pipe Size	Tube Size	Water Flowrate		Chemical Details			Wetted Materials
			Max	Min	Chemical	Max	Min	
INJ2260	3 in	1/2 in	300 gpm	200 gpm	Sodium Hypochlorite (SHC)	1.07 gpm	-	316 SS
INJ2262	3 in	1/2 in	300 gpm	200 gpm	Citric Acid (CAS)	0.82 gpm	-	316 SS
INJ2264	3 in	1/2 in	300 gpm	200 gpm	Sodium Bisulfite (SBS)	0.25 gpm	-	316 SS
INJ2266	3 in	1/2 in	300 gpm	200 gpm	Sulfuric Acid (SAS)	0.29 gpm	-	316 SS
INJ2268	3 in	1/2 in	300 gpm	200 gpm	Sodium Hydroxide (SHX)	0.90 gpm	-	316 SS
INJ2410	10 in	3/4 in	1000 gpm	250 gpm	Chlorine Solution (CLS)	17.2 gpm	17.2 gpm	316 SS
INJ2420	MXR	3/4 in	1000 gpm	250 gpm	Chlorine Solution (CLS)	17.2 gpm	17.2 gpm	316 SS
INJ2510	MXR	1/2 in	1000 gpm	250 gpm	Sodium Hydroxide (SHX)	6.6 gpd	0.2 gpd	316 SS
INJ2610	3 in	1/2 in	120 gpm	15 gpm	Backwash Coagulant (BWC)	6.0 gpd	0.7 gpd	316 SS

PART 3 EXECUTION

3.01 GENERAL

A. The equipment shall be installed in strict accordance with the applicable sections of Division 1 and the respective manufacturer's instructions and recommendations.

3.02 INSTALLATION

A. The equipment shall be installed and tested under the direction of factory trained personnel as specified in Section 43 05 11. The installation shall be certified on Form 43 05 11-A specified in Section 01 99 90.

3.03 TESTING

A. After installation, the equipment specified in this section shall be completely tested to ensure compliance with operating requirements and flows recorded in a test log. Field testing shall be in accordance with the testing procedures in Section 01 45 20.

END OF SECTION

SECTION 46 43 76

INCLINED PLATE SETTLERS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes inclined plate settlers and all appurtenant work, complete and operable, in accordance with Contract Documents for:
   1. Inclined Plate Settler Equipment in four (4) existing sedimentation basins.

B. Requirements include furnishing individual inclined plate pack assemblies for installation in concrete basins as shown on the drawings and specified herein. Supplier shall also provide layout for future plate installation, if shown on drawings, including support spacing.

C. Plate pack assemblies shall include the following Manufacturer supplied items: plates; frames; troughs; flow control baffles; embedment pieces; support columns; support beams; anchor assemblies; and bolts for attachment to steel and concrete supports.

1.02 RELATED SECTIONS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 11 80: Environmental Conditions
   2. Section 01 33 00: Submittal Procedures
   3. Section 01 73 24: Non-structural Components and Non-building Structures
   4. Section 01 78 23: Operation and Maintenance Data
   5. Section 01 79 00: Demonstration and Testing
   6. Section 05 05 20: Anchor Bolts
   7. Section 05 50 00: Metal Fabrications
   8. Section 43 05 11: General Requirements for Equipment

1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
AISC 341	Specification for Structural Steel Buildings
AISC 360	Seismic Provisions for Structural Steel Buildings
AISC 370	Specification for Structural Stainless Steel Buildings

Reference	Title
ANSI/NSF 61	Drinking Water System Components
ASTM A36	Standard Specification for Carbon Steel
ASTM A167	Standard Specification for Stainless and Heat Resisting Chromium-Nickel Steel Plate, Sheet and Strip
ASTM A267	Stainless and Heat Resisting Steel Bars and Shapes
ASTM A320	Alloy Steel Bolting Materials for Low Temperature Service
ASTM A480	General Requirements for Flat-Rolled Stainless and Heat Resisting Steel Plate, Sheet and, Strip
AWS D1.1	Structural Welding Code – Steel
AWS D1.6	Structural Welding Code – Stainless Steel
IBC	International Building Code (with Local Amendments)

1.04 SYSTEM DESCRIPTION

A. One Inclined Plate Settler Manufacturer shall supply all equipment specified in this Section.

B. Plate settler equipment, including place modules (or packs), frames, effluent troughs, and support system shall be installed in two new sedimentation basins at the City Creek Water Treatment Plant located in Salt Lake City, Utah.
   1. Each plate settler system shall be installed in a sedimentation basin for the purpose of removing solids from water.

C. Basis of Design:
   1. The structural and mechanical design for the inclined plate settlers are based on information provided by the listed Inclined Plate Settler Manufacturers. Layouts and drawings show orientations for the first listed manufacturer. Fundamental changes in the configuration of the plate settler system will not be allowed. The Supplier shall submit drawings and supporting documents, identifying all proposed changes, to the Engineer for approval. Supporting documents shall delineate all proposed changes including complete structural calculations stamped and signed by a Structural Engineer registered in the state of Utah.
   2. Process Design:
      a. Troughs shall be designed to allow a maximum of 5 inches of headloss as flow passes from plate settlers into effluent troughs over a weir at the design flow rate.
      b. The maximum feed velocity into the plate pack shall be 0.5 ft/sec to prevent floc destruction and hydraulic disturbances.
      c. Feed through the bottom end of the plate shall be minimized to prevent solids re-entrainment.
      d. Effluent troughs are to be located on each side of plate packs to prevent maldistribution.
   3. Structural Design:
      a. The structural design of the plate settler system shall be in accordance with the requirements of the International Building Code (IBC).

b. Inclined Plate Settler support frames shall be designed for the worst-case load condition of an empty basin and full effluent troughs. The effluent troughs shall be designed such that maintenance personnel can walk on the troughs when the troughs are empty.

c. Plate settlers, frame, supports, troughs, and anchorage system shall be designed per seismic criteria, specified in Section 01 73 24 including effects of water slosh during a seismic event.

D. Inclined Plate Settlers:

1.	Total Sedimentation Basin Design Capacity:	50 gpm
2.	Number of Basins	1
3.	Maximum Design Flow Rate per Basin:	50 gpm
4.	Minimum Design Flow Rate per Basin:	15 gpm
5.	Maximum Hydraulic Flow Rate per Basin:	50 gpm
	a. plate settlers must pass this flow without submerging the weirs or troughs; this is not the design process flow	
6.	Maximum Design Effective Hydraulic Loading Rate:	0.30 gpm/ft^2
7.	Total Effective Projected Settling Area Percentage (efficiency):	80%
8.	Minimum Projected Settling Area per Basin:	209
9.	Water Temperature Range:	33 to 80 °F
10.	pH Range (standard units):	6.0 to 9.0
11.	Angle of inclination between the plates and the horizontal:	55 degrees
12.	Maximum Dose of Primary Coagulant	TBD
	a. System shall be compatible with all ferric- and aluminum-based coagulants	

E. Basin Geometry:

1. Each sedimentation basin is approximately 60-feet wide and 360-feet long; each sedimentation basin has a long side (after the cross-collector channel) and a short side (before the cross-collector channel). Plates will be install on the long side only over chain & flight solids removal equipment. Supports will be installed in both the long side and short side.
2. The rows of plate packs within the basin shall be laid as indicated on the Drawings. This will accommodate cantilevered walkways that do not extend over the plate pack frame. The minimum clearance between the edge of the plate pack frame and the wall is shown on the drawings.

F. Weirs:

1. Adjustable weirs shall be gasketed.

G. Responsibilities:

1. Plate Settler Manufacturer is responsible for delivery of equipment and supplies required under these specifications.
   a. Plate settlers shall be constructed of materials, certified or classified by NSF or underwriters laboratories as meeting ANSI/NSF Standard 61.

b. Proper coordination and integration of all equipment required for supply in the basins, including plate pack assemblies, support beams and columns, and all other associated work shown on the drawings and specified in the Contract Documents.

c. Ensuring that the plate settler system shall be properly coordinated and will function as a unit in accordance with these specifications.

d. Ultimate responsibility for equipment coordination, installation, operation, and guarantees.

2. A General Contractor (Contractor) will be selected under a later bid package to install the equipment. The Contractor will be responsible for:

a. Proper coordination with Suppler and installation of all equipment in the basins including plate pack assemblies, support beams and columns, piping, and all other associated work shown on the drawings and specified in the Contract Documents.

b. Ultimate responsibility for equipment installation.

1.05 PERFORMANCE REQUIREMENTS

A. The inclined plate settlers shall operate to meet the following performance conditions. In the event of noncompliance, the Inclined Plate Settler Manufacturer shall make all necessary adjustments, repairs and/or modifications necessary to meet the requirements before the Work will be accepted.

1. Maximum Design Flow Rate per Sedimentation Basin = 50 gpm
2. Minimum Design Flow Rate per Sedimentation Basin = 15 gpm
3. Minimum Freeboard within Effluent Trough = 5 inches @ Maximum Hydraulic Flow Rate
4. Maximum Headloss Induced by the Plate Settlers = 1.5 inches @ 50 gpm (Measured from the weir elevation to the basin water surface upstream of and outside of the first plate pack).
5. Maximum acceptable daily average turbidity in the plate settler effluent trough shall be no greater than 1.0 NTU.

1.06 SUBMITTALS

A. All submittals shall be as specified in Section 01 33 00.ction Submittals – Product Data and Shop Drawings:

1. A copy of this specification section, and those listed below with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Owners Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the

specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. A copy of the contract document Process and Instrumentation diagram I-70-102 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
3. Product Data and Calculations:
    a. Design calculations to substantiate the proposed plate settler design. Calculations shall include at least the following:
        1) Plate area calculations.
        2) Detailed hydraulic calculations, including a hydraulic profile, at maximum design sedimentation basin and plant flow rates, across the inclined plate settlers showing the water surface elevations in the sedimentation basins upstream of the plate packs, through the effluent troughs, and into the settled water channel at the point of connection with the effluent troughs. Hydraulic calculations shall also include effective hydraulic loading rates of the units and flow velocities between plates and between rows of plate packs; flow velocities throughout the unit (feed box velocities, plate influent velocities, and plate velocities).
        3) Headloss through unit.
        4) Water surface elevations upstream of the effluent weir, in the effluent trough and in the sedimentation basin. Show these elevations on the submittal drawings.
        5) Effective hydraulic loading rates of unit.
        6) Maldistribution testing results.
        7) Weight of the equipment and its distribution on the supports for worst- case design conditions.
    b. Structural Calculations:
        1) The Supplier shall submit complete structural calculations stamped and signed by a Structural Engineer registered in the state of Utah, in accordance with Section 01 33 00. The calculations shall demonstrate full compliance with the structural requirements specified for this Project on the Drawings and in Section 01 73 24.
4. Shop Drawings: Submit drawings and descriptive data of inclined plate settlers for review. Sufficient information is to be provided to show equipment conforms to specification requirements and allows for proper installation of equipment by Contractor. This includes, but is not limited to the following:
    a. Complete dimensional, and installation drawings and details.
        1) Elevations of weirs, flumes, troughs, and other controls;
        2) Materials and details of construction;
        3) Pertinent manufacturer’s data and details of special features;
        4) Load distributions for the plate packs onto the supports (for the worst case design condition)

5) Certified dimensional drawings for plate settlers and support system. Include support anchor bolt and anchorage details.
6) Fabrication drawings, including weld types

b. Diagram of the system that details which part of the equipment is completely submerged during normal operation and at the air/water interface.
c. Flow diagrams of system showing location of equipment and devices;
d. Parts list and other materials,
e. Recommended shipping and storage procedures.
f. Installation details and procedures identifying acceptable methods of lifting, lateral movement, leveling, and anchoring.
g. Material data sheets.
h. Conformance with ANSI/NSF 61 classification.
i. Cross sections and details, as required, to satisfy Engineer and Contractor for the detailed design and location of all connecting or adjacent structural and mechanical items such as foundation, anchor bolts, steel and concrete supports, piping, conduit, etc.
j. Any recommended or required deviations from the dimensions and locations of connecting or adjacent items as shown in the Drawings shall be described completely in the submittal.
k. Operation and maintenance data per Section 01 33 00 required prior to submittal of Owners manuals.

5. Experience and References:
   a. Provide documentation indicating manufacturers qualifications as outlined in Section 1.06 of this specification.
   b. Provide contact name and phone number for reference on previous projects.
6. Welder certifications from a recognized testing laboratory demonstrating that the plate pack welders are qualified and experienced in welding stainless steel; and will demonstrate testing of welders using different types of welds, welding positions, etc.

B. Informational Submittals:
   1. Installation Manuals:
      a. The Inclined Plate Settler Manufacturer shall provide electronic copies of written Installation Manuals. The installation manuals shall provide complete and clear field erection instructions as well as recommended storage procedures prior to installation. The installation manuals shall be submitted at least two (2) weeks prior to shipping the first set of plate packs to the Project Site.
      b. Installation procedures identifying acceptable methods of lifting, lateral movement, leveling, and anchoring. Also include procedures for connecting the plate pack units to one another and to the settled water channel.
   2. Installation certification per Part 3.

C. Closeout Submittals – Operations and Maintenance Manuals:
   1. The Supplier shall submit Owners Manuals in accordance with Section 01 78 23. The manuals shall address the following areas:
      a. Brief description of inclined settling plate components;
      b. Routine maintenance and cleaning procedures;

c. Operation and maintenance instructions, parts list, illustrations and diagrams.
d. Final reviewed shop drawing submittal.
e. As-built drawings.

1.07 QUALITY ASSURANCE

A. Manufacturers Qualifications:
1. Experienced in the production and manufacture of substantially similar equipment during the 5 years prior to the issuance of this contact, and able to submit evidence of satisfactory operation in at least 5 different installations.
2. Plate settler manufacturer to provide support system troughs, plate settler modules, and all other components required providing a complete and operational plate settler system. All components shall be provided by a single manufacturer. The support system shall include all frames, columns, and beams required for a complete installation.
3. The manufacturer shall be solely and fully responsible for the warranty and mechanical design adequacy of all the provided components under this section.

B. Shop Inspection:
1. Shop inspection may be required by the Owner at its own expense. The Supplier shall give at least three (3) weeks notice to the Construction Manager prior to beginning of any fabrication work so that inspection may be provided. The Supplier shall furnish all facilities for the inspection of materials and workmanship in the shop and inspectors shall be allowed free access to the necessary parts of the works. Inspectors shall have the authority to reject any materials or work which does not meet the requirements of these Specifications. Inspection at the shop is intended as a means of ensuring high quality workmanship and of facilitating the work, but it is expressly understood that it will in no way relieve the Supplier from responsibility for furnishing proper materials or workmanship under this Specification.
2. Plate pack units shall be completely assembled in the shop to assure accurate plate spacing.

C. Workmanship:
1. Workmanship in the fabrication of the inclined plate settlers shall be first-class, including the following requirements. The assembled plate packs shall have members that are straight and true. Structural distortions, warps, and other defects shall not be present in the plate pack assemblies before or after installation in the sedimentation basins. All exterior surfaces and edges of the plate packs shall be smooth. Sharp corners shall be ground round and smooth.
2. All welding shall be done in accordance with the latest applicable code and other pertinent standards of the American Welding Society (AWS). Qualification of welders shall be in accordance with AWS standards. Welding of stainless steel shall be performed by welders experienced in stainless steel welding. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS Code. Upon completion of welding, all weld spatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workman- like appearance, with uniform weld contours and dimensions. Finished welds shall be neat in appearance.

1.08 DELIVERY, STORAGE AND HANDLING

A. Packing and Shipping: Pack as required for shipping and outdoor storage at the project site for up to 6 months. Provide lifting lugs or other means for unloading and/or installation. Include special handling instructions and provide picking spreader as needed. Plate settlers shall be shipped with cardboard end caps and corner pads to protect plates from damage during shipping and storage.

B. Storage and Protection: The Contractor will prepare the staging area for storing plate packs. The area shall be as designated on the Drawings. The storage area shall be graded with aggregate rock to form a firm, well-draining storage area. Plate packs shall be covered and kept clean at all times.

C. Protect finished surfaces which may be damaged during installation with removable tape or suitable alternate.

1.09 SPARE PARTS

A. Special tools as required for assembly or disassembly of the plate settlers and support system.

B. Spare parts as recommended by the manufacturer packed in containers which are clearly identified as to their contents. Pack all items for long periods of storage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer: Provide equipment as manufactured by the following:
   1. Meurer Research, Inc. (MRI).
   2. Jim Myer and Sons (JMS).

2.02 GENERAL

A. All equipment shall be designed for continuous, 24-hour operation, exposed to the elements in a basin with no cover. All parts of the product shall be amply proportioned for all stresses, which may occur during fabrication, installation, and operation.

B. Stainless steel nameplates giving the name of the manufacturer, model number, the rated capacity, shipping and operating weights, and any other pertinent data shall be attached to each unit.

C. The plate settler manufacturer shall coordinate the design and installation of the plate packs and support system with the hydraulic solids scraper manufacturer.

D. Fabrication:
   1. All welding shall be performed by qualified personnel in strict accordance with manufacturer recommendations and in accordance with the latest requirements of AWS.
      a. Sharp corners of all cut or sheared edges shall be ground smooth where practical.

b. Welds shall be rough ground to remove heavy weld ripple or unusual roughness per the latest recommended practices of AWS.
c. Acceptable welding methods shall include MIG, TIG, stick-electrode, or as per the manufacturer's recommendations.

2. All welds shall be fully cleaned and passivated after completion of welding operations. All pastes and solutions shall be disposed of in accordance with all applicable laws and regulations.

E. The components of the Inclined Plate Settlers shall be made from the following material:
1. Plates: Type 304 SST (Type 304L SST if welded)
2. Frames: Type 304L SST
3. Columns: Type 304 SST (Type 304L SST if welded)
4. Beams: Type 304 SST (Type 304L SST if welded)
5. Trough/Flume Assembly: Type 316 SST (Type 316L SST if welded)
6. Baffles Type: 316 SST (Type 316L SST if welded)
7. Adjustable Weirs: Type 316 SST (Type 316L SST if welded)
8. Gaskets: EPDM Rubber
9. Nuts, bolts, fasteners: 316 SST (in accordance with Section 05 50 20)

F. All components of the Inclined Plate Settlers that are not completely submersed under normal operation or at the air-water interface shall be constructed out of Type 316 stainless steel (Type 316L SST if welded).

2.03 PLATE PACKS

A. Plate settler modules consisting of metal sheets stacked and assembled in a pack or module.

B. The channels shall have a sufficient cross-sectional area, and shall be oriented on an angle of 55° from the horizontal, to promote gravity drainage of solids collected on the plate bottoms.

C. Minimum perpendicular plate spacing shall be 2 inches, nominal.

D. Plate settler modules shall fit in the corresponding sedimentation basin as indicated on the Drawings.

E. The plates shall be proven to support a 30 lb. solids loading.
1. The plate shall be designed to handle a 30 lb. solids loading evenly distributed over the plate without failing, buckling, yielding, or creating a permanent deformation. The plate shall not exceed a maximum deflection of L/140 anywhere along the plate width and shall have center stiffeners as needed to prevent deflection of plates.
2. The manufacturer shall provide a stamped report from a third-party testing laboratory in compliance with ASTM E330 and proving that the L/140 testing criteria is met.

F. Connectors
1. Flexible connections shall be provided between each plate pack. Connectors shall be Neoprene sleeves with Type 304 stainless steel clamps.

2. All gaskets and sleeves shall be neoprene.

2.04 EFFLUENT ASSEMBLY

A. The effluent assembly shall consist of side-mounted effluent troughs for each row of plate packs, and protected by perimeter aprons or separation walls that prevents flow in the basin from bypassing the plate packs. Both shall be constructed with a minimum thickness of 14 gauge.
   1. Troughs shall be of the dual side load arrangement, meaning one effluent trough per frame assembly shall not be allowed.
   2. The effluent trough shall be sized by Supplier. Flow into the trough will be controlled by continuous weirs.

B. The effluent trough shall be of continuous construction, or have a sealed connection, by use of SST and NSF 61 approved gaskets, between adjacent plate packs.

C. Minimum Number of Troughs and Minimum Trough Depth per Basin:
   1. Minimum Number of Troughs: 2
   2. Minimum Trough Depth of Inclined Settler Plate:
      a. Exterior to Plates: 8 inches

D. The effluent trough/ flume assembly shall be reinforced as necessary to handle the loads transmitted from the effluent trough to the effluent flume, and the loads due to maintenance activities. Lateral stiffness and rigidity shall be provided if necessary through the use of spreaders placed at strategic points along the length of the flume and fastened with Type 316 stainless steel hardware. The stiffeners shall be above the design operating water level in the flumes. To satisfy horizontal and vertical deflection requirements, angle stiffeners shall be used to reinforce the sides of the trough.

E. Each trough shall be equipped with adjustable weirs for leveling during initial installation and to provide an even flow distribution during operation. Troughs located above the plate settlers obstructing access to the tops of the plates shall not be accepted.

2.05 TOP FLOW CONTROL DEVICE

A. Each plate shall be equipped with an integral Type 304 stainless steel top flow control device (angle or perforated tube) to ensure that there is an even flow distribution across the entire surface area of the plate.

B. Top flow control device shall provide a suitable walking surface for routine cleaning and maintenance without the use of a temporary walking surface, such as plywood. No part of the plate settler system shall deform or fail due to walking on top of the plates.
   1. The manufacturer shall provide a P.E. stamped report from a third-party in compliance with ASCE 7-10 (Minimum Design Loads for Buildings and Other Structures) referencing catwalks for maintenance access. Specifically the flow control deck shall be designed using a minimum uniformly distributed live load of 40 psf and a minimum concentrated live load of 300 pounds. The top flow control device shall not experience any buckling, permanent deformation, or yielding.

2.06 ACCESSORIES

A. All brackets, fasteners, anchor bolts and similar items necessary to secure and support the furnished equipment on concrete beams within the basin shall be furnished by the equipment manufacturer and installed by the Contractor in accordance with the manufacturer's instructions.

B. Plate settler manufacturer shall equip the center most effluent trough per basin with a 1-inch stainless steel threaded nipple located below the water surface elevation within the effluent trough for sampling purposes as indicated by the Drawings. The location of the nipple shall be at the end of the trough and shall be coordinated with the Contractor.

2.07 SURFACE FINISH/CLEANING

A. All Stainless Steel components shall be protected, cleaned and tested as follows:
   1. Stainless steel components shall be protected from carbon steel contamination during fabrication and assembly as defined in Paragraph 8 of ASTM A380. Surfaces surrounding joints shall be cleaned as discussed in Paragraph 6.3 prior to welding. Careful adherence to good stainless-steel practices may minimize descaling and cleaning requirements.
   2. Welding temperatures shall be carefully monitored as to not sensitize the material and thereby increase the risk of intergranular corrosion.
   3. After completion of welding, all surfaces shall be descaled as necessary using methods described in Paragraph 5 of ASTM A380. Welded surfaces (including surfaces within the heat affected zone of the weld) shall be descaled using a pickling solution as discussed in Paragraph 5.2. Surfaces shall be thoroughly rinsed in accordance with Paragraph 5.2.5.
   4. Following descaling, all surfaces shall be cleaned as necessary using methods described in Paragraph 6 of ASTM A380. Final cleaning of all surfaces shall be in accordance with Paragraph 6.4 of ASTM A380.
   5. Upon completion of cleaning, all surfaces shall be visually inspected in accordance with Paragraph 7.2.1 prior to testing. Any gross indications of Iron as defined in Paragraph 7.2.1.1 shall be cleaned as necessary.
   6. Testing to ensure proper passivation and cleaning has occurred shall be as defined in Paragraph 7.2.5 of ASTM A380. First, perform a water-wetting and drying test on all stainless-steel surfaces in accordance with Paragraph 7.2.5.1 of ASTM A380 or a Practice A – Water Immersion Test as defined in Paragraph 14.1 of ASTM A967. Failed areas shall be re-cleaned and retested using a Copper Sulfate Test in accordance with Paragraph 7.2.5.3 of ASTM A380 or Practice D – Copper Sulfate Test found in Paragraph 14.4 of ASTM A967. Any remaining failed areas shall be cleaned using a nitric acid solution in accordance with Table A2.1 Part II of ASTM A380 followed by retesting of all affected areas using a Copper Sulfate Test.
   7. Manufacturer shall notify Engineer of any failed tests. No equipment shall be shipped without certification that all surfaces have passed inspection and testing. Manufacturer shall remove test chemical in accordance with the testing manufacturers recommendations. No visible indications of Iron may exist prior to shipment. Any evidence of rust or blooming upon arrival on site shall be the responsibility of the manufacturer to address.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect all components, upon delivery, for shipping damage and conformance to specifications prior to installation. Repair or replace damaged items as directed by Construction Manager, including visible corrosion, at no additional cost to the Owner. Only factory-trained manufacturer's representative shall perform repair work.

3.02 INSTALLATION

A. Plate settler modules shall be provided in such configurations to minimize, if not eliminate, field modification.

B. Contractor will install Supplier’s products in accordance with manufacturer’s instructions.
   1. In general, installation shall include:
      a. Install bolts, nuts, and washers at all mounting locations for each plate pack.
      b. Install shims under anchor plates where necessary to meet the installation tolerances.
      c. Install flume connections to the collector trough and between plate packs.
      d. Install gaskets, bolts, nuts, and washers.
      e. Adjust weir plate to required elevation.
      f. Apply sealant around all gaskets after plate pack connections have been made and around all weir plates after elevations have been verified.
      g. Level plate pack supports with non-shrink, nonmetallic grout.

C. All brackets, fasteners, and similar items necessary to secure the furnished equipment in the basin shall be furnished by the Manufacturer.

3.03 FIELD TESTING

A. Contractor will perform all testing under the supervision of the Manufacturer’s representative. The Contractor will conduct all specified tests and furnish all labor, equipment, materials, and supplies to conduct these tests. The Contractor will be responsible for sample collection, shipping, and analyses of all test samples. The Contractor will provide the Construction Manager with sufficient advance notice of the testing to enable the Supplier and Construction Manager to witness the tests.

B. Supplier shall provide the Contractor with protocols for all tests describing the type of test, test procedures, instrumentation used, proposed flow rates, and other information necessary to describe the proposed testing plan.

C. The effluent quality of the settled water must meet the performance requirements specified herein.

D. The inclined plate settlers shall demonstrate compliance with the specified hydraulic requirements. The inclined plate settlers shall be demonstrated to have the hydraulic capacity specified without maldistribution of flow or requiring more than the specified maximum headloss.

E. If a basin or individual plate pack assembly fails to meet specified performance requirements, the Supplier shall direct the Contractor to make necessary corrections and retest the settling basin or plate pack until the performance test is satisfactorily completed. No additional payments will be made for retesting.

F. Functional Testing
   1. Complete Functional Testing in accordance with Section 01 79 00.

G. Installation Tolerance:
   1. For the weirs on the plate pack trough, the maximum allowable variation shall be ±1/8-inch to achieve the water surface elevation indicated on the Drawings at maximum flow.

H. Tolerance shall be verified prior to filling with water. The Contractor will provide equipment to verify tolerances. Operational Testing: As specified in Section 01 79 00.
   1. Upon completion of testing, the Supplier shall submit to the Construction Manager a copy of the completed test reports. Reports shall include description of the units tested, test procedures, test flow rates, pressures, levels, and all other data and results required to demonstrate that the equipment meets specified requirements.

3.04 MANUFACTURER'S FIELD SERVICES

A. The Contractor shall coordinate field service work with the Manufacturer's representative, Owner, and Construction Manager prior to initiating such work.

B. The manufacturer shall provide a qualified field technician to perform the following:
   1. Inspect the system before initial start-up and verify that system has been correctly installed, as specified herein and in Section 01 79 00, prior to filling with water.

C. The Manufacturer shall provide the services of a factory field service technician or Engineer as follows:
   1. To include, but not limited to, four (4) trips to the site, totaling 20 days of on- site work. A day on-site shall be considered to be 8 hours in duration.
   2. Observe/advise the Contractor on the installation of the settler equipment.
   3. Check and verify that installation of the plate pack assemblies is in accordance with the Drawings and Manufacturer's installation instructions. The installation shall be certified on Form 43 05 11-A as specified in Section 01 99 90
   4. Assist in start-up and testing of the settler system as required.
   5. Instruct the Owner's personnel on operation and maintenance of the settlers. Personnel instruction shall consist of not less than one (1) day of classroom and field training. Subjects shall include the following:
      a. Troubleshooting.
      b. Operating adjustments for performance optimization.
      c. Preventive maintenance.
      d. Maintenance procedures.

END OF SECTION

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SECTION 46 61 16

GRANULAR ACTIVATED CARBON MEDIA

PART 1 GENERAL

1.01 SUMMARY

A. Scope: This section specifies granular activated carbon (GAC) media for five gravity flow GAC contactors for removal of Total Organic Carbon (TOC) and trace organic compounds. The GAC Contactors will be preceded by a membrane filtration process. The media shall be 100 percent virgin GAC.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not listed below.
   1. Section 01 11 80: Environmental Conditions
   2. Section 01 33 00: Contractor Submittals
   3. Section 01 91 00: Commissioning, Testing and Start-up
   4. Section 01 78 23: Operation and Maintenance Data
   5. Section 43 05 11: General Requirements for Equipment
   6. Section 46 31 13.13: Vertical GAC Liquid Adsorption Contactors

1.03 REFERENCES

A. This section contains references to documents that are a part of this section, as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM C127	Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
ASTM D2862	Standard Test Method for Particle Size Distribution of Granular Activated Carbon
ASTM D2866	Standard Test Method for Total Ash Content in Activated Carbon
ASTM D2867	Standard Test Methods for Moisture in Activated Carbon

Reference	Title
ASTM D4607	Standard Test Method for Determination of Iodine Number of Activated Carbon
AWWA B604-96	Standard for Granular Activated Carbon
AWWA B100	Standard for Granular Filter Media
NSF 61	ANSI/NSF Standard Drinking Water System Components – Health Effects

1.04 SUBMITTALS

A. Action Submittals – Shop Drawings:

1. Procedures: Section 01 33 00.
    a. Copy of this Section, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Checkmarks (✓) to denote full compliance with a paragraph as a whole. Underline deviations and denote by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections with justification(s) for any requested deviation will cause rejection of the entire submittal with no further consideration.
2. Detailed product information for the activated carbon proposed for the job, including verification of all properties specified in paragraph 2.01, as well as total volume per bed.
3. Detailed product information for the activated carbon proposed, including verification of all specified properties.
4. NSF 61 certification.
5. Source of coal, location of manufacture of the GAC, and description of the agglomeration/thermal process used in the manufacture of the GAC.
6. Media sample (2 lb.) accompanied with a certificate, stating the sample is from the same batch that will be shipped to the Project.
7. Suppliers' standard data for proposed GAC media:
    a. Iodine number
    b. Moisture content
    c. Effective grain size
    d. Uniformity coefficient
    e. Abrasion number (Ro-tap Method)
    f. Trace capacity number
    g. Gradation – sieve analysis – tabular and plotted data
    h. Pore size distribution
    i. Average apparent specific gravity (wetted) and in-place media density
    j. Bulk density (backwashed and drained)
    k. Total Surface Area (Nitrogen BET Method)
    l. Water Soluble ash
    m. Pore volume
    n. Water Soluble phosphate

o. Water extractables
p. Acid Solubility

8. Affidavit of compliance certifying conformance to the manufacturing experience requirement specified in paragraph 2.02.
9. Furnish headloss curves for the supplied granular activated carbon filter media during filter operation under conditions specified herein.
10. Furnish filter bed expansion curves for granular activated carbon filter media bed expansion during backwashing as a percent of in-service bed depth versus backwash water flow rate for the range of operating conditions specified herein.

B. Informational Submittals:
1. Procedures: Section 01 33 00 and 01 78 23.
2. Detailed description of the procedure for installation and commissioning of the activated carbon.
3. Operation and maintenance manuals as per requirements of Section 01 78 23.

C. Closeout Submittals: Submit the following information:
1. Written report of field tests, procedures, instrumentations, test conditions and results including all data as necessary to demonstrate compliance.
2. Manufacturer's certification of proper installation (43 05 11-A)

1.05 QUALITY ASSURANCE:

A. Testing Laboratory. The manufacturer shall procure the services of an independent testing laboratory to test the granular activated carbon filter media prior to submittal of samples. The qualifications of the laboratory to perform the analyses as required by AWWA B100 – Granular Filter Material and in accordance with ASTM D75 as modified and supplemented by AWWA B100, as certified by an appropriate agency such as the American Association for Laboratory Accreditation, shall be submitted and approved by the Engineer prior to any testing.

B. Samples: After approval of the supplier's standard information provided in the Shop Drawings, the Contractor shall furnish to the Engineer a sample of the granular activated carbon filter media proposed for use. The sample shall be placed in a tight jar holding not less than one liter and shall be properly labeled. In addition, submit laboratory analyses in accordance with AWWA B100 – Granular Filter Material of the granular activated carbon filter media sample. The analyses shall include gradation (including calculated effective size and uniformity coefficient), average apparent specific gravity, bulk density (backwashed and drained), total surface area, water soluble ash, pore volume, iodine number, moisture content, abrasion number, phosphate (water soluble), and water extractables, and acid solubility. Gradation results shall be provided in tabular form and plotted on semi-log or log-probability paper. Revised filter media compatibility calculations shall be submitted by the Contractor utilizing the results of the laboratory analyses. The Engineer's approval of the submitted granular activated carbon filter media samples shall not be construed as signifying that the materials satisfy the requirements of the Contract Documents and shall in no way relieve the Contractor of the obligation to satisfy all the requirements herein.

C. Test Data: Before the granular activated carbon filter media is shipped to the Site, the granular activated carbon filter media bags shall be divided into lots for testing, with the size of a lot no larger than one truckload. Representative samples shall be collected from each lot of bags using a core sampler and then combined to produce the required composite sample. The minimum number of samples per lot and the minimum size of the composite sample shall be per AWWA B100 – Granular Filter Material.
   1. The Contractor shall furnish, to the Engineer for approval, laboratory analyses for each lot of granular activated carbon filter media in accordance with AWWA B100 – Granular Filter Material. The analyses shall include gradation (including calculated effective size and uniformity coefficient), average apparent specific gravity, bulk density (backwashed and drained), total surface area, water soluble ash, pore volume, iodine number, moisture content, abrasion number, phosphate (water soluble), and water extractables, and acid solubility. Gradation results shall be provided in tabular form and plotted on semi-log or log-probability paper.
   2. The Contractor shall schedule the granular activated carbon filter media testing and deliveries to allow ample time for sampling, testing, submittal of test results, and Engineer review. No granular activated carbon filter media lots shall be shipped prior to Engineer's approval of the test results for that lot.
   3. Prior to shipment to the Site, the manufacturer shall verify that all bags of granular activated carbon filter media are properly labeled and that they clearly indicate the customer, lot, and bag number on the bags. The Contractor shall verify same upon receipt of each shipment at the Site.
   4. The Owner reserves the right to re-test (at the Owner's expense) the granular activated carbon filter media at any time upon delivery or placement.

1.06 DELIVERY, STORAGE AND HANDLING

A. Procedures shall be per Section 01 66 00.

B. For slurry shipping, the carbon shall be delivered in enclosed food grade hopper trucks dedicated to hauling GAC for potable water applications. The trailers shall be lined with an FDA approved lining material for potable water use. The transport vehicle shall be capable of filling and emptying the adsorber tanks via direct connection to the quick-connect fittings.

1.07 WATER QUALITY

A. Estimated influent water quality (Maximum).
   1. Turbidity (NTU): 0.1 NTU
   2. TOC (mg/L): 2.9

1.08 WARRANTY AND PERFORMANCE GUARANTEE

A. Supply warranty per General Conditions

B. Performance Test Requirements per Section 01 91 00 and as follows:
   1. GAC Contactors:
      a. GAC effluent water quality required:
         1) Turbidity ≤ 0.1 NTU (No increase in Turbidity from Membrane Effluent).

2) TOC < 0.2 (After 15 min EBCT)

PART 2 PRODUCTS

2.01 GRANULAR ACTIVATED CARBON FILTER MEDIA

A. General: Granular activated carbon filter media and granular activated carbon filter media testing methods shall conform to the requirements of AWWA B100 – Granular Filter Material and AWWA B604 – Granular Activated Carbon, except as otherwise indicated.

B. Filter System: The GAC shall be compatible with the undrain system specified in Section 43 31 13.13 Paragraph 2.05.D.

C. Uniformity: The granular activated carbon filter media provided in the WORK shall be equal in all respects to the approved samples. The Engineer may require that the Contractor furnish samples for testing by the Owner during the preparation and placing of the granular activated carbon filter media.

D. Material Quality: The granular activated carbon filter media shall be mined in the United States, be 100% virgin, and be composed of hard and durable grains. Average apparent specific gravity shall be determined by the procedure set forth in ASTM C 128 – Test Method for Specific Gravity and Absorption of Fine Aggregate, which requires soaking the sample in water for 24 hours. The granular activated carbon filter media shall meet the physical properties indicated herein and be manufactured from only selected grades of bituminous coal combined with suitable binders as required to produce a highly active, durable granular material capable of withstanding the abrasion and dynamics associated with repeated backwashing, surface washing, and hydraulic transport. Lignite, peat, wood, coconut shell, and sublignite based activated carbons will not be accepted. Activation shall be carefully controlled to produce a material having a high internal surface area with optimum pore size for effective adsorption of a broad range of high and low molecular weight organic contaminants. The density and particle size shall be designed for packed bed type of adsorption. The material shall have sufficient density to allow backwash agitation and bed expansion yet settle rapidly for immediate resumption of service. The granular activated carbon filter media shall be visually free of foreign materials such as clay, dirt, etc. and free from any significant amounts of iron sulfides, clay, shale, dust, or other foreign matter.

Effective Size (mm)	0.55 – 0.75
Uniformity Coefficient (Max)	1.90
Apparent Density (Tamped)(g/cc)	0.54
Bulk Density (Backwashed and drained)(lb/ft^3)	28.0 – 29.0
Total Surface Area (Nitrogen BET Method)(mg/g)	950 to 1050
Water Soluble Ash (Maximum)(Percent)	0.50
Pore Volume (cc/g)	0.9 – 1.0
Iodine Number (Minimum)(mg/g)	1000
Moisture Content by Weight (Maximum)(Percent)	2.0
Abrasion Number (Ro-tap Method)(Minimum)	75
Water Soluble Phosphate, (Maximum)(Percent)	0.10
Water Extractables, (Maximum)(Percent)	1.0

E. Acid Solubility: The granular activated carbon filter media shall contain less than five percent acid-soluble material when tested per AWWA B100 – Granular Filter Material.

F. Particle Size and Gradation: The granular activated carbon filter media shall have the effective size and uniformity coefficient indicated herein. Effective size is defined as the theoretical size of the sieve (in millimeters) that will pass 10 percent of the sample by weight. The uniformity coefficient is defined as the theoretical size of the sieve (in millimeters) that will pass 60 percent of the sample by weight divided by the effective size. The size of the granular activated carbon filter media shall be determined by screening through standard sieves that have been calibrated per ASTM E 11 - Specification for Wire-Cloth Sieves for Testing Purposes.

2.02 FILTER DESIGN/OPERATION

A. GAC Vessel Manufacturer shall supply granular activated carbon filter media as part of the equipment package as defined in Section 43 31 13.13. Selected GAC shall meet the performance/design criteria as outlined in Paragraph 2.02 of Section 43 31 13.13.

2.03 MANUFACTURERS

A. The following candidate manufacturers can produce products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard products will comply with the requirements of this Section. Candidate manufacturers include.
   1. Calgon Carbon Corporation F400,
   2. Evoqua
   3. or approved equal.

B. The GAC shall be manufactured in the United States by a producer certified for ISO 9001:2015 quality standards and at the specific plant or site holding such certification. A copy of the valid certificate shall be submitted. The manufacturer shall have at least 15 years of experience manufacturing and regenerating GAC in the United States.

PART 3 EXECUTION

3.01 INSTALLATION

A. GAC media shall be installed after Contractor has completed cleaning, testing, and disinfection of vessel walls, underdrains, and appurtenant piping. In no case shall GAC media be installed prior to acceptance of hydrostatic pressure testing results and bacteriological testing results.

B. The GAC shall be installed in strict accordance with manufacturer's recommendations. The representative shall have at least 5 years of experience in performing the carbon exchange procedures. Each bed shall be packed uniformly to the density specified with sample probes installed as shown. The packed bed shall contain no void pockets including bed areas around the sampling probes and near the filter/contactor walls. Each bed shall have a smooth surface with uniform bed depth throughout.

3.02 COMMISSIONING, TESTING AND STARTUP

A. Commissioning, testing and startup shall conform to the requirements of Section 01 91 00.

B. The commissioning period shall be conducted under the supervision of the manufacturer's representative and shall be continuous for a minimum of 3 days to complete the following services:
   1. Inspection of the installed equipment.
   2. Supervision of GAC loading and installation.
   3. Startup assistance.
   4. Troubleshooting.
   5. Operator training.

C. Commissioning shall strictly follow the manufacturer’s recommended protocol for an initial soak and backwash sequences which are critical to achieving NSF 61 Compliance. All related wastewater (drain or backwash) shall be disposed off-site by the Contractor until the water no longer contains unacceptable levels of metals as required for compliance with NSF 61.

D. Manufacturer's representative shall operate the system and verify that the media conforms to requirements. Representative shall revisit the Plant as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

END OF SECTION

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SECTION 46 61 33

MEMBRANE FILTRATION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. This section includes the design, supply, start-up services, and testing of the membrane filtration system. The system will include membrane modules; valve racks (including piping integral to the valve racks and conduit, wire, cable, tubing and fasteners integral to the valve rack); feed pumps; strainers; backwash and CIP systems; valves and valve actuators; blowers; compressed air equipment; instrumentation devices, PLC, panels, and control software; chemical cleaning pump systems, neutralization pump systems; backwash coagulant pump system, automatic on-line integrity testing equipment, etc.; as necessary for a complete, working system. The Seller will clearly itemize all items of equipment to be furnished including points of termination and exceptions to items not furnished.

1.02 GENERAL

A. Equipment furnished under this section shall be fabricated, assembled, and placed in proper operating condition in full conformity with drawings, specifications, Engineering data, instructions, and recommendations of the equipment manufacturers, unless exceptions are noted by the Engineer.

B. General Equipment Requirements: The requirements specified in Section 43 05 11: General Requirements for Equipment shall apply to the equipment furnished by Seller as specified in this Specification section. Refer to Section 01 73 24 for seismic requirements. The Seller shall prepare and submit seismic calculations for equipment anchorage, structural systems analysis, and load data, stamped and signed by a registered Arizona Civil or Structural Engineer. Equipment mounting requirements shall comply with Section 43 05 13: Rigid Equipment Mounts unless otherwise specified or indicated on the drawings.

C. All anchor bolts, nuts and washers shall be provided by the Installation Contractor as specified in Section 05 05 20 Anchor Bolts and Section 43 05 11: General Requirements for Equipment. The Seller shall be responsible for designing and furnishing details on all of the anchor bolts required for the installation of equipment being furnished by Seller. All bolts, nuts, washers, and other fasteners shall be ANSI Type 316 stainless steel, except where galvanized fasteners are allowed by the Engineer.

D. Power Supply:

1. Power supply to the membrane system equipment shall be 120 volts, one-phase, 60 Hz unless noted otherwise. Where process equipment is provided with its own local control panel, the control panel shall be configured such that a single 120 volt, one-phase circuit shall be connected to the control panel to power the respective equipment and instruments. Equipment local control panels shall contain control power transformers where lower voltages are required for purposes of control.

2. Power supply to system control panels containing PLCs and controllers shall be 120 volts, single-phase, 60 Hz unless noted otherwise. External 120 volts, single-phase power shall be provided to the master PLC panel, each train control panel, and any other PLC or I/O panel required except those that are skid or rack mounted with other equipment that is receiving a single source of power as specified in this section. The external 120V AC shall provide power to panel lights and receptacles and will serve as the input to the internally mounted Uninterruptible Power Supply (UPS).The UPS shall provide 120V AC power to the panel mounted control devices.
3. All electrical work provided by the Seller shall comply as specified including with the "Electrical Requirements" of this section, the latest version of the National Electrical Code, and all applicable local codes.

1.03 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below:
   1. Applicable sections of Division 1
   2. Section 05 05 20 - Anchor Bolts
   3. Section 05 50 00 - Metal Fabrications
   4. Section 26 05 00 - Common Work Results for Electrical
   5. Section 26 09 16 - Electrical Controls and Relays
   6. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
   7. Applicable sections of Division 40, Process piping, tubing, valves and actuators
   8. Section 40 61 13 - Process Control System General Provisions
   9. Section 40 61 21 - Process Control System Testing
   10. Section 40 63 43 - Programmable Logic Controllers
   11. Section 40 67 00 - Control System Equipment Panels and Racks
   12. Section 40 71 00 - Flow Measurement
   13. Section 40 72 00 - Level Measurement
   14. Section 40 73 00 - Pressure Strain and Force Measurement
   15. Section 40 74 00 - Temperature Measurement
   16. Section 40 75 00 - Process Liquid Analytical Measurement
   17. Section 40 78 00 - Panel Mounted Instruments
   18. Section 43 05 11 - General Requirements for Equipment
   19. Section 43 05 13 - Rigid Equipment Mounts
   20. Section 43 05 14 - Machine Alignment
   21. Section 43 23 89.13 - Horizontal Centrifugal End Suction Frame Mounted Pumps
   22. Section 43 23 92.02 - Multistage Vertical Centrifugal Pumps – Volume 2 WTP
   23. Section 43 41 43.13 - High Density Crosslinked Polyethylene Tanks
   24. Section 46 33 42.13 - Mechanically Actuated Diaphragm Type Metering Pumps
   25. Section 46 41 17 - Inline Static Mixer and Injectors (Static Mixer not in Seller Scope)

1.04 REFERENCE SECTIONS

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. American Society of Mechanical Engineers (ASME)
   2. ASME Boiler and Pressure Vessel Code
   3. ASME B16.5 – Pipe Flanges and Flanged Fittings
   4. ASME B31.3 – Process Piping
   5. ASTM International (ASTM)
   6. ASTM A 193 – Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
   7. ASTM A 36, Standard Specification for Structural Steel
   8. American National Standards Institute (ANSI)
   9. American Welding Society (AWS)
   10. Hydraulic Institute (HI)
   11. Institute of Electrical and Electronic Engineers (IEEE)
   12. National Electric Code (NEC)
   13. National Electrical Manufacturers Association (NEMA)
   14. Standards of National Electrical Manufacturers Association
   15. Standards of American Water Works Association (AWWA)
   16. Underwriter's Laboratory (UL)
   17. NSF International (NSF)

1.05 DEFINITIONS

A. Backwash: The periodic reversal of flow through the membrane, typically done sequentially or simultaneously with air scour, followed by a feed flush, for the purpose of removing accumulated solids from the membrane surface. Backwashes shall not include any chemical addition. "Backpulse" and "reverse filtration" shall be considered synonymous with backwash. Residuals from backwashing are referred to as backwash waste water.

B. Buyer: May reference either the Contractor or Owner.

C. CIP: Clean-In-Place. See Maintenance Clean and Recovery Clean.

D. Contractor: Synonymous with general contractor

E. Engineer: Brown and Caldwell

F. Flux: Volumetric flow rate of the water passing through a membrane expressed in terms of volume per unit membrane area per unit time (gallons per square foot per day, or gfd).
   1. Net Flux shall equal the Net Design Capacity in gallons per day, divided by the membrane surface area in square feet.

2. Instantaneous Flux is the gross filtration production capacity in gallons per day of a membrane filtration train measured at any given time that the train is in production divided by the active membrane surface area of the membrane filtration train.
3. Maximum instantaneous flux is the highest instantaneous flux allowance for the membrane system. This is a not-to-exceed limit under all circumstances.

G. HMI: Human-Machine Interface

H. I/O: Input/Output

I. LRV: Log Removal Value

J. Maintenance Clean: The periodic application of chemical solution(s) to a membrane for the intended purpose of increasing membrane permeability. A Maintenance Clean must be fully automated. A Maintenance Clean has the following characteristics:

K. Maintenance Cleans utilize the CIP system specified in these documents.

L. A Maintenance Clean has a maximum duration of 2.5 hours, from the time the train is taken out of production to the time it is made ready for the next filtration cycle.

M. Use of Maintenance Cleans are subject to frequency restrictions as defined in this section.

N. MCP: Master Control Panel

O. Membrane Feed Water: A blend of raw water from Lake Powell and treated backwash waste water.

P. Membrane Filtration System: A complete system including multiple membrane filtration trains and ancillary equipment.

Q. Membrane Module: The smallest component of the Membrane Filtration System in which a collection of membrane fibers are held vertically and bonded at the top and the bottom forming a module.

R. Membrane Train: A membrane filtration train has a single feed water connection point and operates in parallel with other membrane filtration trains and is independently controlled, backwashed, and cleaned. A train shall be fully isolatable from other trains for maintenance of modules, automatic valves, and instrumentation. Each train consists of multiple modules, valves, instrumentation, electric and pneumatic controls, support system for membrane modules, support system for valves, interconnecting piping between modules, fasteners, and appurtenance to make a complete and fully operable unit. Each train includes a direct integrity test system and a continuous indirect integrity monitoring system.

S. MIT: Membrane Integrity Test

T. Owner: Navajo Nation

U. P&ID: Piping & Instrumentation Diagram

V. Permeability: A calculated parameter of flux normalized against transmembrane pressure. It is expressed in terms of volume per unit membrane area per unit time per unit pressure, expressed in gfd/psi. Since the viscosity of water varies with temperature, TMP also varies with water temperature. Permeability is the parameter that is typically corrected to account for temperature variations. Adjusting the permeability for temperature allows the influence of fouling to be isolated from those variations caused by temperature. It is convention to temperature correct permeability to 20°C.

W. Permeate: That portion of the feed water that passes through the membrane. Synonymous with filtrate.

X. PLC: Programmable Logic Controller

Y. Rack Drain: The periodic draining of the modules in the membrane train for the purpose of removing solids from the modules. To occur once per day on days when a Maintenance Clean is not performed.

Z. Raw Water: Untreated surface water from Lake Powell

AA. Recovery:
1. Recovery = Net Permeate (MGD)/Gross Feed (MGD) times 100.
2. Gross Feed includes the daily totalized flow from the lake water and treated backwash waste water less the strainer waste volume.
3. Net Permeate is the total daily membrane filtered water volume minus filtered water volumes used for backwashing, chemical cleaning, and associated rinsing/flushing sequences.

BB. Recovery Clean: The periodic application of one or more chemical solutions to a membrane for the intended purpose of increasing membrane permeability. A Recovery Clean must be fully automated. A Recovery Clean is differentiated from a Maintenance Clean by its duration (requiring more than 2.5 hours downtime, including rinsing) or by the number of different chemical cleaning solutions used. A single Recovery Clean event may include consecutive use of chlorinated and acidic cleaning solutions with rinse steps in between. Recovery Cleans utilize the CIP system specified in these documents.

CC. Seller: Membrane System Supplier

DD. TMP: Transmembrane Pressure is the pressure drop across the hollow fiber membranes. Measured as the difference between the pressure on the feed side of a membrane filtration train minus the pressure downstream of the membranes. The units of TMP are pounds per square inch (psi).

EE. Treated backwash waste water: a stream of membrane backwash waste water that has been reconditioned prior to blending with the raw water upstream of the membrane system. This reconditioning takes place in an additional engineered and controlled process step which provides dedicated coagulant addition, pH adjustment (if required), and solids settling.

FF. UF: Ultrafiltration

GG. WTP: Water Treatment Plant

1.06 ADMINISTRATIVE REQUIREMENTS

A. Coordination Meetings:
   1. The Seller shall meet with the Contractor and Engineer for a kickoff meeting and other meetings throughout the construction phase to address any issues related to the project. The meetings shall normally be held virtually unless an in-person meeting is deemed necessary.
   2. The Seller shall participate in Instrument and Control Coordination Meetings with Engineer, Contractor, Control and Instrumentation System Integrator, and other equipment sellers providing major portions of the process train. The purpose of these meetings is to ensure the equipment operates as the Seller intends, interfaces with the plant operating system, and that the different process segments operate together properly. These sessions will normally be held virtually unless an in-person meeting is deemed necessary.
   3. The Seller shall plan for a minimum of three (3) trips to attend in-person meetings for a duration of two (2) day each trip to support the project prior to the startup, commissioning and Operator Training discussed in Part 3 of this Section.

1.07 SUBMITTALS

A. Seller shall submit five (5) engineering submittals in a staged submittal format. Seller may stage the submittal information according to their preference. However, the engineering submittals as a whole shall include the following as a minimum:
   1. Action Submittals:
      a. A copy of this specification section, and those listed below with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. If deviations from the specifications are indicated, and therefore requested by the Seller each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Project Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Seller with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
      b. Completed Certificate of Unit Responsibility attesting that the Contractor has assigned, and that the manufacturer accepts unit responsibility in accordance with the requirements of this Section and Section 43 05 11-1.02. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.

c. Process Flow Diagram (PFD) showing the relationship between the major components in the system. It must show all the unit operations in the process, but not necessarily all the equipment supplied by the Seller.

d. Piping & Instrumentation Diagrams (P&IDs) will clearly show the locations and types of equipment items including control valves; piping schematic (including pipe size and material); instruments; equipment sizing and control detail. Diagrams shall clearly show equipment that is shipped as part of skid-mounted assembly, and items that will be shipped loose for installation by others.

e. General Arrangement (GA) Drawings for all skidded equipment supplied by the Seller to indicate equipment arrangement. As a minimum, drawings shall show dimensions, sizes and weights of associated skidded equipment, locations of connections and anchoring points, and all tie in points for interconnecting piping detailing the type, size, elevation and position. Any interconnecting piping outside the scope of the Seller need not be shown. Drawings shall indicate scope of supply and scope of installation to clearly identify equipment, piping instrumentation, etc. provided by the Seller as part of the membrane package.

6. A copy of the contract document Process and Instrumentation diagrams I-21-101 through I-22-117 and I-70-105 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

g. Wiring and schematic diagrams and details

h. Major equipment specification sheets and product catalog cut-sheets on all equipment items, clearly marked to show the applicable model number, optional features, and intended service of each device. Note, any component provided by the Seller specified using a different Section (i.e. pumps, valves, instruments, etc.) shall be submitted under that specific Section and not as part of the Submittals for this Section. These components will have additional submittal information that shall be provided.

i. Details on strainers including manufacturer, model number, materials, controls, screen opening size in microns, flow capacity, system configuration, backwashing requirements, and hydraulic performance curve (headloss as a function of flow).

j. Details on blowers as specified in the applicable blower section including general arrangement drawings, connection points electrical schematics and diagrams, anchoring points and anchoring requirements, etc.

k. Details on air compressors and accessories as specified in the applicable air compressor section including general arrangement drawings, connection points electrical schematics and diagrams, anchoring points and anchoring requirements, etc.

l. Control philosophy, including description of all operating cycles and tables to show their timing and impact on membrane filtration unit queuing/availability and flows during cycles, including summary of peak and low flow periods during each step in operating cycles and related duration of flow conditions.

m. Control Logic & Sequence Charts: An Excel Workbook consisting of several worksheets which describe the required process automation in detail including system modes, equipment modes, interlocks, permissives, sequences, and alarms. The two (2) most significant worksheets are the Sequence Chart (SC) and the Control Logic Chart (CLC).

n. A copy of the contract document Electrical and Instrumentation control one-line diagrams E-00-111, E-00-131, E-00-501 through E-00-516, and E-00-701, relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

o. Electrical Drawings: Includes the following components: Electrical schematic diagrams, and electrical bill of material.

p. I/O List: A complete listing of the analog and digital I/O on the system. Shows where the I/O is being sent to/from and which panel it is wired to. It identifies the exact location of each IO point on the control modules of ever PLC component of the system.

q. PLC and Control Panel Layout Drawings: A physical layout of the main control panel and remote I/O panels. Includes the panel front elevation view for both the interior and exterior, the terminal block layouts, and the bill of material.

r. Images of proposed control screens

s. Description of archiving system, including examples of related tables, graphs, frequency and method of archiving.

2. Informational Submittals:

   a. Start-Up Procedures

   b. Factory Acceptance Test results

   c. Installation Instructions

   d. The Seller shall prepare a draft and final Installation Contractor Information Package to be made available to and used by the Owner, Engineer, and/or bidders on that portion of the Project, and the information package shall include as a minimum:

      1) Final Technical Submittals.

      2) Equipment delivery schedule.

      3) Special shipping/handling information/requirements, including information on storing/handling limitations of equipment, including membrane modules, regarding storage conditions, such as time, temperature, exposure to UV light and/or any other conditions that shorten equipment service life and/or impact warranties.

      4) Special installation requirements.

      5) Draft startup plan and schedule.

      6) Scope of Seller Services during construction phase.

e. The Installation Contractor Information Package shall be organized and assembled. Draft and final copies of the Installation Contactor Information Package shall be in digital and hard copy format per Section 01 33 00. Five hard copies assembled in suitable three-ring binders and CDs shall be provided.

f. Equipment and System Performance Testing Plan

g. Commissioning Plan

h. Operations and Maintenance Data

i. Draft and final Operation and Maintenance Data and Manuals for all equipment furnished by the Seller shall be submitted in accordance with Section 01 33 00 Submittals. Draft operations and maintenance manuals shall be submitted at least 5 months prior and final operations and maintenance manuals at least 1 month prior to commencement of training or any startup/testing activities. The O&M manuals shall include results of equipment performance testing and a copy of the affidavit stating equipment has been calibrated, tested and is ready for full time operation. O&M Manuals shall include a printout of all RO PLC programming logic and a list of all information exchanged with the Plant Control System, including data table addresses.

j. A final as-built set of P&ID's, and other drawings provided in the Primary submittals, incorporating all comments made by the Engineer on previous submittals.

k. Training Manuals

3. Closeout Submittals:

a. Include final reviewed submittals.

b. Include as-built drawings

c. Conform submittals to the requirements of Section 43 23 03.

d. Spare Parts

e. Procedures: Section 01 33 00 and 01 78 23.

f. Special Tools

g. As-Commissioned PLC and HMI Program Files

h. Certificates, Warranties and Guarantees

1.08 QUALITY ASSURANCE

A. The equipment and material to be furnished under this contract will be free from defects in materials and workmanship. The complete membrane filtration system will be provided by one Manufacturer having complete responsibility for the design of the system, including all necessary ancillary equipment, to provide a complete operating system.

B. The materials and equipment furnished by the Seller will be installed by a general contractor. The Seller will be required to provide factory trained technical representatives to monitor installation and to provide technical assistance for start-up, commissioning and testing of the Seller's equipment. The Seller will be responsible for the membrane system's ability to meet the specifications and performance guarantees.

C. Seller Qualifications:

1. The membrane system furnished under this section shall be designed, coordinated and supplied by a single manufacturer or supplier. At a minimum, the Seller shall meet the following qualifications and related data shall be submitted with the Seller initial bid:
    a. The Seller shall be an ISO 9001 Registered Corporation or shall have a rigorous company QA/QC system compliant with ISO 9001 (or approved equal), regularly engaged in the business of supplying membrane systems of similar size and scope and shall have been in business for at least ten years.
2. The Seller shall have designed and constructed at least five Membrane filtration systems on water, all of which must be a minimum of 2.0 million gallons per day (mgd) capacity. Two of the five systems must each have a permeate capacity of greater than 4.0 mgd, and have been in operation for at least 3 years at the time of bid submittal. Project references shall be submitted with the bid, including at least five references, project location, permeate capacity, date of contract, date of startup, current status, and Owner's contact information (contact name, address, and telephone number).
3. The Seller shall be the fabricator of the hollow-fiber membrane modules.
4. The Seller will be credited only for experience of its business entity. Experience of sub-contractors cannot be used to meet the experience requirements. Previous experience of team members or employees while working at other organizations cannot be used to meet the experience requirements.
5. The Seller shall assign a qualified employee as project manager for this project. The project manager shall have managed a minimum of 3 membrane filtration projects. A minimum of at least one project must include the design, installation supervision, and startup of a membrane system. Documentation (such as a resume) on the proposed project manager shall be submitted with the bid.
6. The Seller shall demonstrate the existence of sufficient service capabilities within the United States, including documentation of the ability to respond to a service request within 3 business days, and data on the staffing level, location and telephone number of the service office.

D. Unit Responsibility. Assign unit responsibility, as specified in Section 43 05 11, to the MFSS manufacturer for the equipment specified in this Section and referenced Sections, and for the VFDs specified in Section 26 29 23. Provide a completed and signed Unit Responsibility Certification Form (Form 43 05 11-C, Section 01 99 90).

1.09 SHIPMENT AND STORAGE

A. Shipping and Handling shall be in accordance with the requirements specified in Section 01 66 00 Product Storage and handling.

B. Shipment of membrane system to be coordinated with Engineer and Contractor. Agreed date of shipment must be confirmed in writing by Engineer.

C. Seller is responsible for shipment with insurance and all associated costs to project site on agreed date.

D. Contractor will unload and store products on site in a manner that prevents damage according to Seller's recommendations. Protect delivered equipment from the weather, UV, excessive humidity, excessive temperature variation, and dirt, dust, or other contaminants per Seller's recommendation.

E. Seller will mark each box to show its net weight in addition to its contents.

1.10 WARRANTIES

A. Mechanical Warranty:

1. The Seller shall provide a mechanical warranty for all equipment supplied by the Seller, excluding membrane modules. The mechanical warranty period on all equipment supplied, excluding modules, is twelve (12) months from the date of substantial completion or eighteen (18) months from equipment delivery, whichever occurs first. The mechanical warranty is only applicable to equipment supplied by the Seller. Seller's obligation under this warranty is to repair or replace, at its factory, any device or part thereof, which shall prove to have been thus defective. Warranty repair, replacement or re-performance by Seller shall not extend or renew the applicable warranty period.
2. The Seller assumes no liability for any damage to the equipment caused by inadequate storage or handling per manufacturer's recommendations in supplied technical literature, or by defective or sub-standard workmanship of materials provided by the Contractor or any other third party responsible for handling, storing, or installing the equipment.
3. The Contractor undertakes to give immediate notice to the Seller if goods or performance appear defective and to provide the Seller with reasonable opportunity to make inspections and tests. If the Seller is not at fault, the Contractor shall pay the Seller the costs and expenses associated with the inspections and tests.
4. Goods shall not be returned to the Seller without the Seller's permission. The Seller will provide the Contractor with a "Return Goods Authorization" (RGA) number to use for returned goods. All returns are INCOTERMS 2020 FCA – Seller's Facility. All costs associated with the removal and shipment of the defective part from the Contractor's facility to the Seller's facility and all costs related to return shipment to the Contractor's facility and installation of a repaired or replacement part shall be the Contractor's responsibility.
5. Implied warranties, including but not limited to warranties of fitness for particular purpose, use or application, and all other obligations or liabilities on the part of the Seller, unless such warranties, obligations or liabilities are expressly agreed to in writing by the Seller, are null and void.

B. Membrane Warranty:

1. The Seller shall provide a membrane warranty for all membrane modules supplied by the Seller. The membrane warranty is a ten (10) year warranty, with the first twenty-four (24) months offered as a full replacement warranty and the remaining ninety-six (96) months as a prorated warranty. The membrane warranty shall begin at the date of substantial completion or three (3) months from the date of delivery of the membrane modules, whichever occurs first.

2. Full replacement means that in the case of a valid warranty claim for a membrane module failure, Owner receives a replacement membrane module and does not pay for the value of use of the membrane module prior to failure.
3. Prorated replacement means the Owner pays for actual use of a membrane module from which the Owner has derived value over time. Prorated replacement allows the Seller to pay reasonable compensation under warranty for any product use not enjoyed by Owner due to premature failure.
4. The membrane warranty applies only to the membrane modules supplied under the contract of sale. Membrane module means the hollow fiber ultrafiltration membranes and the potted plastic headers. This warranty does not cover air piping to the membrane module, permeate piping from the membrane module, piping connection fittings, connection hardware with their associated components including but not limited to spacers, aerator tubes, aerator assemblies, screen, module dummies or module blanks.
5. The Seller warrants that its membrane modules will be free from defects due to faulty materials or errors in manufacturing workmanship. Regular membrane module inspection and normal fiber repair shall be the responsibility of the Owner. All replacement membrane modules will be shipped on the basis of INCOTERMS 2020 FCA – Seller's Manufacturing Facility. All ancillary costs including but not limited to bagging, boxing, crating, freight, freight insurance, applicable taxes, import duties, certifications, brokerage, receiving, forklift services, storage at site, reattachment hardware, hose/clamp/camlock replacement, crane services, installation, fiber repair materials, glycerin flushing, commissioning, and waste disposal are the responsibility of the Owner.
6. During the membrane warranty period, membrane modules found to be defective due to faulty materials or errors in manufacturing workmanship will be replaced as follows:
    a. Any membrane element found to be defective within the full replacement warranty period will be repaired or replaced.
    b. For any membrane element found to be defective during the pro-rated warranty period, the cost for replacement will be determined as follows. The pro-rated replacement cost to the Owner will be equal to the number of whole months elapsed between the membrane module claim date and the warranty start date multiplied by the Membrane Module Replacement Price (MMRP) (adjusted for changes in the Consumer Price Index + 1.0%) divided by the total membrane warranty duration in months.
7. Membrane Module Replacement Price (MMRP): The Seller's Bid shall include a Membrane Module Replacement Price. Seller shall guarantee this price for fifteen (15) years from the start date of the membrane warranty. Pricing for replacement modules is subject to adjustment for inflation from the date of the Seller's Bid according to the North American Consumer Price Index (CPI) + 1.0%. If the same module is not available due to product improvements, an equivalent price per gallon of treatment capacity will be used. The Membrane Module Replacement Price is not applicable for membrane modules purchased for any non-replacement purposes, such as for flux reduction or hydraulic capacity increase. Modules purchased under these scenarios will be purchased at the list price at the time of order. Membrane Module Replacement Price does not include bagging, boxing, crating, and will be shipped on the basis of INCOTERMS 2020 FCA Seller's Manufacturing Facility. The Membrane Module Replacement Price shall be quoted without taxes.

8. The Membrane Module Replacement Price refers to replacement of installed membrane modules under the following two scenarios:
    a. Replacement of membrane modules during the warranty period. Under this scenario, membrane modules replaced under warranty shall assume the remainder of the warranty from the membrane being replaced, with such warranty to be not less than a two (2) year full replacement warranty from the date of replacement with a new membrane module.
    b. Replacement of membrane modules no longer under warranty but still within the guaranteed membrane replacement price period. Under this scenario, membrane modules purchased to replace a membrane module whose warranty has expired shall be provided with a standard two (2) year full replacement warranty.

C. Performance Warranty:
1. The Seller shall provide a performance warranty for all equipment and modules supplied by the Seller to provide protection and assurances to the Contractor and Owner with respect to the ability of the Seller's system to meet the established performance criteria. The performance warranty period is the duration of the Performance Test and extends for a period of twelve (12) months after completion of a successful performance test. The Seller shall meet the performance criteria defined in Paragraph 2.03 while operating within the conditions specified in this Section. The performance warranty is only applicable to equipment and modules supplied by the Seller.
2. If any changes are made to the Seller's system without the Seller's written consent that would affect the Seller's ability to meet this performance warranty, then all obligations to the Contractor and Owner under this performance warranty shall be deemed discharged.
3. A thirty (30) day Performance Test shall be conducted to demonstrate the ability of the Seller's system to meet the required performance. The Performance Test shall begin within thirty (30) days of completion of commissioning of the Seller's system, or three (3) months from the date of delivery of the membranes, whichever occurs first.
4. During the Performance Test, when operating on influent water quality as outlined in Table 1 and Table 2 found in paragraph 2.02.B and paragraph 2.02.C, respectively, the Seller's system will demonstrate performance in accordance with the following guaranteed performance criteria:
    a. Permeate water quality as per Table 3 in Paragraph 2.02.E.
    b. Design Capacity (Net) with two (2) membrane trains in service at ≥ 8°C: 1.613 MGD
    c. Design Capacity (Net) with one (1) membrane train out of service at ≥ 8°C: 0.8064 MGD
5. The guaranteed performance criteria shall be met on a daily basis over a 24-hour period (midnight to midnight).
6. The Performance Test is subject to the following conditions:
    a. Test methodology will be defined in a Performance Test Plan issued by the Seller and agreed upon by all involved parties.
    b. Owner shall operate the system during the Performance Test, with support from the Seller.

c. Backwash waste treatment operations will be optimized to maintain the design influent water quality and for the optimal performance of the equipment being performance tested.

d. Testing shall include sampling to ensure feed water quality is within the parameters listed in Table 1 and Table 2. A minimum of three (3) grab samples shall be collected per parameter, evenly spaced over the course of the Performance Test. Samples shall be collected and analyzed in accordance with industry standards at an accredited third-party laboratory at the Owner's expense.

e. Performance with respect to effluent water quality will be demonstrated based on on-line instrumentation. Should results include values beyond the stated guarantees due to process upsets outside of Seller's control, additional testing shall be performed to establish that the equipment is not meeting performance requirements.

f. Seller shall issue a report summarizing equipment performance during the Performance Test.

7. Upon successful completion of the Performance Test, the Seller shall give written notice to the Contractor to that effect. Within two (2) weeks immediately following receipt of such notice, the Contractor shall notify the Seller in writing that it accepts the system, or that it does not accept the system, in which latter case the Contractor shall state the specific reason for non-acceptance. In the absence of such reply from the Contactor within the two (2) week period, the system shall be deemed to have been accepted.
8. If, based on the results obtained at the completion of the Performance Test, it becomes apparent that the performance does not meet the guaranteed performance, then additional Performance Tests shall be conducted by the Owner at a time mutually agreed between the Seller and the Owner. In such event, the Seller shall be responsible to undertake all necessary reasonable corrective measures in an effort, consistent with commercial and technical reasonableness, to bring the equipment up to the guaranteed performance levels.
9. Once a satisfactory Performance Test has been completed, substantial completion is triggered, the twelve (12) month extended performance warranty commences, and the mechanical and membrane warranties begin.
10. If the system fails to perform during the guarantee period, the Seller shall remedy the situation by modifying operating protocols, cleaning procedures, repairing/replacing damaged membrane modules, and/or adding equipment at no cost to the Owner.
11. Seller shall be responsible for all costs associated with supply and installation of new equipment required for remedy of the system to meet performance requirements. Seller shall develop a plan for addressing and correcting the issue and shall submit the plan in writing to the Owner within thirty (30) days from the notification.
12. Should necessary modifications result in an increase in the usage of chemicals from the as proposed values, the Seller shall negotiate with the Owner to determine an equitable settlement agreeable to both parties.

D. Warranty/Performance Guarantee Conditions:

1. Sellers warranty language and limitations, if different than as specified herein, shall be agreed to in writing prior to awarding the contract to the Contractor.

2. The Owner recognizes the following occurrences may void the warranties and performance guarantees set forth in this section:
    a. Unauthorized alteration of equipment manufactured or supplied by the Seller.
    b. Operation of equipment outside the parameters specified in Paragraph 2.02.C.
    c. Catastrophic exposure to chemical not typically associated with water treatment as a result of accidents, vandalism or other acts that are outside the bounds of routine and normal water treatment plant operation.
    d. Use of water treatment chemicals, chemical cleaning solutions or cleaning procedures other than those approved by the Seller as defined in the O&M manuals provided by the Seller as submitted to the Owner.
    e. Exposure to water treatment chemicals at concentrations exceeding levels or contact times other than those approved by the Seller as defined in the O&M manuals provided by the Seller as submitted to the Owner.
    f. Improper maintenance of the equipment as defined in the O&M manuals provided by the Seller as submitted to the Owner.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Seller shall provide a complete working system including all piping, valves, actuators, instrumentation and appurtenances to automate operation of the system as defined herein and on the Piping and Instrumentation Diagrams.

B. The Seller shall also be the manufacturer of the membrane module.

C. The Engineer designed the membrane system and building layout around the ZeeWeed® 1500 RMS modules manufactured and sold by Veolia. As such, many key components in the layout of the process area of the building (interconnecting piping, valves, pumps, position of floor penetrations, instrumentation, ancillary equipment, cleaning and backwash processes, etc.) reflect the effort spent during the design process in close collaboration with Veolia to provide a highly customized design tailored to the expectations of the Client and site conditions. Thus, the Engineer has specified Veolia as the approved Seller for the membrane treatment equipment.

D. Contractor may propose an alternative Seller for approval by the Engineer. However, alternative Seller must abide by all requirements specified within this Section and other referenced Sections. No exemptions, deviations or alternative designs will be allowed. Any effort required by the Engineer to redesign the system to accommodate an alternative Seller shall be solely born by the Contractor at no cost to the Owner. Cost and time to perform redesign work shall be taken into account by the Engineer.

2.02 CONDITIONS/PERFORMANCE/DESIGN CRITERIA

A. Service Conditions
    1. Refer to Section 01 11 80 for environmental information at the site. Equipment shall be installed indoors in facility protected from the elements.

B. Feedwater Conditions

1. The water source for the project is Lake Powell. There is no pretreatment chemical addition to the raw water (i.e. no polymers, flocculants, coagulants, coagulant aids, oxidants, acids, bases, etc.). Raw water quality parameters from Lake Powell are described in Table 1 and forms a basis for membrane system design:

Table 1: Raw Water Quality

Parameter	Units	Average	Minimum	Maximum
Alkalinity	mg/L as $CaCO_3$	148.8	138.0	154.0
Total Hardness	mg/L as $CaCO_3$	326.7	280.0	340.0
pH	-	7.5	6.2	9.1
Temperature	°C	8.9	7.9	12.6
Total Organic Carbon (TOC)	mg/L	2.7	2.4	2.9
Dissolved Organic Carbon (DOC)	mg/L	2.48	2.3	2.7
Turbidity	NTU	0.88	0.18	10.0
Total Dissolved Solids (TDS)	mg/L	634	556	690
Calcium	mg/L	87.3	73.2	92.8
Barium	mg/L	0.106	0.094	0.110
Sulfate	mg/L	241.8	212.0	263.0
Total Iron	mg/L	0.038	0.020	0.081
Total Manganese	mg/L	0.00110	0.00070	0.00150
Total Aluminum	mg/L	0.044	0.011	0.080
Total Silica (SiO_2)	mg/L	0.5	BDL	2
Langelier Saturation Index (LSI)	-	0	-0.5	0

C. Treated Backwash Water Recycle Steam

1. The membrane system must be designed to accommodate treated backwash waste recycle ahead of the membrane system. The treated backwash waste process will be designed and installed by the Owner based on the following provisions:

   a. Chemical cleaning waste will not be recycled.
   b. The treated backwash waste stream will be injected upstream of the strainers, as far upstream in the process as possible to allow blending.
   c. The treated backwash waste stream will represent less than 10% of the feed water to the membrane system and will be fed gradually into the upstream processes. There will be no batch recycling (high volume, short duration) of treated backwash waste.
   d. The treated backwash waste process will include instrumentation and controls which allow for full visibility of the quality (turbidity, pH, etc.) and quantity (flow) of recycle flow and the overall process operation (on/off, chemical dosing status and volumes, etc.)
   e. The treated backwash waste process does not include the addition of lime, polymer, or polymer-blended coagulant.

f. The treated backwash waste process will have the ability to be completely purged or drained of all accumulated solids, water, and chemicals.

g. The treated backwash waste process will be designed, operated, and optimized based on the waste water quality and performance of the membrane system.

2. The treated backwash waste stream will fall within the following parameters.

Table 2: Treated Backwash Water Recycle Stream Water Quality

Parameter	Units	Maximum	95th Percentile
Turbidity	NTU	≤ 5	≤ 2
Total Suspended Solids (TSS)	mg/L	≤ 5	≤ 2
Total Organic Carbon (TOC)	mg/L	≤ 5	≤ 2.5
Total Iron	mg/L	≤ 0.2	≤ 0.1
Total Manganese	mg/L	≤ 0.10	≤ 0.05
Total Aluminum	mg/L	≤ 0.10	≤ 0.05
pH [1]	-	± 0.3 pH units for minimum solubility of the coagulant selected.	

[1] The pH must be controlled through the treated backwash waste water treatment process to minimize the solubility of the metal-based coagulant.

D. Design Criteria and Performance Criteria

1. The membrane system shall meet the following design conditions and performance requirements:

a. Number of membrane trains: Two (2)

b. Minimum spare module space per membrane train: 8%

c. Spare module space is a safety factor for the Seller only – not to be used for future expansion capacity.

d. The membrane system will be designed to provide its rated capacity on a net daily basis. The membrane filtration system design does not include membrane train redundancy. Daily production capacity will be reduced when one of the membrane trains is in Recovery Clean or out of service. The Design Capacity is based on the plant being available for operation 100% of the time.

e. Design Capacity (Net) with two (2) membrane trains in service at ≥ 8°C: 1.613 MGD

f. Design Capacity (Net) with one (1) membrane train out of service at ≥ 8°C: 0.8064 MGD

g. Instantaneous permeate flows will vary as membrane trains cycle through required automatically triggered sequences such as backwashes, Rack Drains, Maintenance Cleans, Membrane Integrity Tests, and Recovery Cleans. Trains will backwash as per the recovery setpoint and perform Rack Drains, Maintenance Cleans, Membrane Integrity Tests, and Recovery Cleans as per a schedule. A train that is in production will not ramp up when another train is in backwash, Rack Drain, Maintenance Clean, Membrane Integrity Test, or Recovery Clean. The feed equipment and controls provided by the Buyer will be responsive and deliver timely flow variation that is appropriate to maintain the level in the Feed Tank during feed demand fluctuations of the membrane system at all capacities.

h. The membrane system must run under dead end filtration whenever it is making permeate. Under no circumstances is cross flow filtration permitted.
i. Recovery (at Design Capacity): 97%
j. The recovery of the membrane system is to be met during steady state operation over the course of a 24-hour period. The recovery of the membrane system is to be met at the Design Capacity. Operation under low flow scenarios can increase the proportion of chemical waste over backwash waste, which under certain conditions may impact the ability of the membrane system to meet the recovery objective.
k. Not-To-Exceed Maximum Instantaneous Flux: 38.0 gfd
l. Maximum Frequency of Maintenance Cleans: 1 per membrane train per day
m. Maximum Duration of Maintenance Cleans: 2.5 hours
n. Maintenance Cleans cannot use heated water/cleaning solutions
o. Maximum Frequency of Recovery Cleans: 12 per membrane train per chemical per year
p. Maximum Duration of Recovery Cleans: 6 hours per chemical
q. Recovery Cleans may use heated water/cleaning solutions
r. Minimum Frequency of Membrane Integrity Test: 1 per membrane train per day

E. Permeate Water Quality (Performance Criteria)
1. The permeate from the membrane system will be guaranteed to meet the following requirements:

Table 3: Permeate Water Quality

Parameter	Units	Value
Turbidity [1]	NTU	≤ 0.1
Log Removal Value (LRV)	-	≥ 3.0 log

[1] 95% of the time
[2] All guarantees are contingent upon proper maintenance, calibration and service of all instrumentation and other related equipment as per the Seller's and original equipment manufacturer's instruction.

2.03 OVERVIEW OF EQUIPMENT OPERATION

A. General
1. The membrane feed water will flow from the Raw Water Tank located on site, which will help equalize the variable flow rate to each train of the membrane system while maintaining a flooded suction at the inlet of the Seller's Feed Pumps. The design is based on the supply of two (2) membrane trains.
2. The pressure on the ultrafiltration (UF) membranes will be provided by the Feed Pump. There is one (1) Feed Pump dedicated per membrane train. Each Feed Pump will be controlled by a VFD (supplied by the Contractor) and the control system will automatically monitor the flow rate and will adjust the pump speed as necessary to maintain the Seller's desired flow rate.
3. The membrane feed water pumped by the Feed Pump will flow through the strainer (one (1) dedicated strainer per membrane train), and then to the membrane train.

4. There will be one (1) dedicated Valve Rack per membrane train, provided by the Seller, which houses, among other things, the following:
    a. Factory-wired instrumentation and valving.
    b. Piping and tubing.
    c. All equipment wired to a local Remote I/O panel.
5. Each membrane train includes the membrane modules. The Seller's ZeeWeed® 1500 RMS modules are self-supporting and modular in nature. The modules contain the membrane fibers. The membrane feed water is pumped into the bottom of the module, pressurizing the water through the pores of the membrane. Clean water (permeate) passes into the permeate cavity of the module. This is known as an "outside-in" flow path. Particles that are bigger than the pore size of the membrane are rejected by the membrane and remain on the feed side of the module.
6. A dedicated turbidimeter will be supplied, by Seller, per membrane train, to measure the turbidity of the treated water before it is discharged to the clearwell.
7. Under normal operation, the membrane trains will automatically cycle between permeation mode and backwash mode. The treated water used for the backwash procedure is collected in the Backpulse Tank (Backpulse Tank supplied by Seller). A Backpulse Pump is used to draw the water from the Backpulse Tank and pump it to the inside of the membrane fibers ("inside-out" flow path). Air is injected to scour the fibers to remove solids through agitation. Two (2) Backpulse Pumps are supplied by the Seller. Backpulse Pump VFDs are by the Contractor. The air used for the backwash procedure is supplied from the Seller-supplied Blower. Two (2) Blowers are supplied by the Seller. The Blower VFDs are by the Contractor.
8. All cleaning activities are automated. Maintenance Cleans can be scheduled and fully automated or can be operator initiated. The membrane trains will return to permeation mode automatically at the completion of the clean. The Recovery Cleans (also known as Clean-in-Place or CIP) are operator-initiated and are also fully automated.
9. The treated water used for the Maintenance Clean and Recovery Clean procedures is taken from the CIP Tank (CIP Tank supplied by the Seller). The CIP system is equipped with an in-line heater to heat the stored water (permeate) before the beginning of a Recovery Clean (in-line heater supplied by the Seller). A CIP Pump is used to transfer the water from the CIP Tank to the membrane train. One (1) CIP Pump is supplied by the Seller. The CIP Pump VFD is by the Contractor. Cleaning chemicals are dosed automatically using chemical dosing pumps. For each chemical Seller will one (1) duty chemical dosing pump. The proposed cleaning chemicals are sodium hypochlorite for the Chlorine Cleans (Maintenance and Recovery Cleans) and citric acid and sulfuric acid for the Acid Cleans (Maintenance and Recovery Cleans). The proposed neutralization chemicals are sodium hydroxide (for pH adjustment of the Chlorine and Acid Cleans), and sodium bisulfite (for dechlorination of the Chlorine Cleans). Neutralization of the used cleaning chemical solution at the end of the chemical clean will be performed using the CIP Tank and CIP pump.
10. The membrane system includes the ability to perform direct membrane integrity testing (MIT) using a pressure decay testing (PDT) method. The MIT will be programmed to occur once per day, per membrane train. The air required for the pressure decay test is provided by an air compressor. One (1) duty stand-by air compressor is supplied by the Seller, in addition to one (1) air receiver tank, one (1)

air drier, and required valves and filters to provide adequately oil-free air to the membranes.

11. All automatic valves on the membrane system are pneumatically actuated. The supplied air compressor also provides air for the pneumatically actuated valves.

2.04 ULTRAFILTRATION MEMBRANE MODULES

A. Provide ultrafiltration membrane modules with hollow fibers operating in an outside to in mode and enclosed in a housing.

1. Ultrafiltration modules will be of hollow fiber construction and configured for a normal filtration flow direction from outside the fiber through to the inside (lumen) of the fiber. The membrane modules will have a nominal pore size of 0.02 microns.
2. Membranes will be NSF 61 certified.
3. Membrane and module will be chlorine and oxidant compatible, to at least 1,000,000 ppm-hours of free chlorine.
4. The membrane fibers will be encased in a PVC housing that is suitable for operating pressures up to 55 psig. The membrane fibers together with the housing will be referred to as a membrane module.
5. The modules will be a 3 piece construction with membrane module, feed, and permeate end caps. The end caps and O-rings will be installed prior to shipment and the assembled modules will be pressure tested to check for leaks.
6. The modules will not require special lifting mechanisms for handling.
7. The maximum acceptable weight for a dry membrane module is sixty-six (66) pounds, and no more than one hundred twenty (120) pounds wet. If the weight is greater, the Seller agrees to supply the Buyer with a lifting apparatus that enables the operator to lift, maneuver, install, and remove a membrane module.
8. Acceptable manufacturer and model: Veolia Water Technologies & Solutions ZeeWeed® 1500 RMS

B. The Seller is responsible for providing a mechanical means by which to support and integrate the membrane modules into a filtration train. The membrane module support system must meet the following requirements:

1. Having no more than four (4) rows in two (2) pairs, with each pair easily accessible from an aisle.
2. Modules can be pinned without the need for removing from the rack, without requiring the train to be taken out of service for more than 10 minutes.
3. Modules must have a clear section of pipe, on the feed/reject to each module that makes it possible to see air bubbles (a sign of membrane leaks).
4. No more than one (1) module need be removed to remove/install any other one (1) module.
5. The Owner does not require the upfront purchase or installation of additional racks to accommodate spare module space.
6. Piping meets all piping velocity requirements.

2.05 VALVE RACK

A. The Valve Rack contains the valves and instrumentation required for the membrane train to cycle through production, backwash, Rack Drain, chemical cleans (Maintenance Cleans and Recovery Cleans), and Membrane Integrity Tests.

B. Provide fully skidded Valve Racks, one (1) per membrane train.

C. Frame:
   1. Provide a single frame to support all piping, instrumentation, and other appurtenances.
   2. The Valve Rack shall be shop assembled to the greatest extent possible.
   3. Provide a frame that can be anchored to a concrete foundation with anchor bolts.
   4. Contractor to provide 304 stainless steel anchor bolts, expansion anchors, or epoxy anchors for anchoring frame to concrete foundation.
   5. All structural components will be ASTM A36 structural steel or equal.
   6. All vertical members will be perpendicular to the base. Perpendicularity will be measured using a 30" Port Austin Level & Tool Manufacturing Co. Level or equal.
   7. All horizontal members will be parallel to the base. Parallelism will be measured using a 30" Port Austin Level & Tool Manufacturing Co. Level or equal.
   8. All tolerances to be +/- 1/16" unless otherwise noted. Tolerances are non-cumulative on string dimensions.
   9. Fabrication Preparation: All mating pieces will be mitered and/or coped in a manner, which will ensure a maximum joint gap 1/16".
   10. Welding: Welding procedures are per ASME Section IX. Each and every seam, miter and/or cope will have a continuous bead or fillet weld on both sides. There will be no evidence of puddling or poor penetration. Flush surface joints will be completely filled to allow the presentation of a continuous uninterrupted surface after finish grinding.
   11. The surface finish shall be coated per Seller's recommendation and with Engineer's written approval. Surface finish shall be compatible with all process chemicals, process water, and process environment.
   12. Coating: Frame coating will be suited for indoor applications to the following standard, or equal:
       a. Aliphatic Acrylic Polyurethane
       b. Surface Preparation: SSPC-SP6
       c. Prime Coat: Tnemec Series 161 #161-32GR, 3 - 4 mils (76-102 microns) DFT
       d. Finish Coat: Tnemec Series 1075-B3178, RAL-5019 Capri Blue, 3 - 4 mils (76-102 microns) DFT
       e. Color: RAL 5019 Capri Blue
       f. Testing: SSPC-PA2
   13. Surface Preparation: Any slag will be completely removed from each weld bead or fillet. Panel mounting area welds are to be ground flush. Remove rust, loose mil scale and other contaminants by sanding, scraping, pneumatic needle gun or other suitable tools. Remove weld spatter with chisels or chipping or grinding tools. Weld flux must also be removed. All sharp points and sharp edges of welds will be ground off with a mechanical grinder.

14. Valve Rack shall be designed and analyzed in accordance with the structural requirements outlined in Section 01 73 24.

D. Piping :
   1. Seller shall refer to the P&IDs for information regarding the three letter process service identifier designated for the piping supplied as part of this package. Seller shall refer to Section 40 05 02 to identify the applicable piping schedules for the process service identifier. Engineer may permit alternate material on a case by case basis upon request.
   2. All piping fasteners shall conform to the requirements outlined in the applicable piping system schedule.
   3. Piping supports shall be in accordance with Section 40 05 01, Section 40 05 07 and Section 40 05 07.13.

E. Valve racks shall be shipped to site fully assembled, wired and must meet the following requirements:
   1. Assembly can be offloaded either by hoist or forklift
   2. Piping shall be securely fastened to frame to prevent any lateral movement.

F. Valve and Instrumentation:
   1. Valves and Instrumentation installed and wired on the Valve Rack provided by the Seller include:
      a. Isolation valve, feed flowmeter, pressure transmitter and pressure switch installed on the feed line.
      b. Set of valves and vent installed on the reject/to CIP Tank line.
      c. Set of valves and vent installed on the CIP recirculation line.
      d. Set of valves, vent, temperature transmitter, and pressure transmitter on the permeate/backwash line.
      e. Set of valves on the membrane aeration line.
      f. Set of valves and pressure transmitter for MITs. For MITs, a high resolution pressure transmitter, accurate to +/- 0.05 psi, installed with isolation hand valve is required.
      g. Permeate Turbidimeter Panel with instrument, instrument auto-cleaner, isolation valves, and needle valves installed on the panel. A degassing column is also included.
      h. All other valve and/or instrumentation marked with a V* (indicating Vendor supplied) as shown on Sheet I-22-101 through I-22-105.
   2. Valves and shall be in accordance with the Division 40 specifications and the applicable table found on Sheet G-00-007 provided as part of this construction package.

G. Solenoid Valve Bank:
   1. All solenoid valves required to drive air actuated valve for the Valve Rack will be housed in a common skid mounted solenoid valve bank located on the Valve Rack. Each solenoid valve will have the ability to adjust the speed of exhaust directly on the valve bank.

H. Accessories:

1. The Valve Rack will include the pneumatic tubing for all valves located on the Valve Rack. Air tubing from solenoid valve to the air actuator will be ¼-inch polyethylene flexible tubing with polypropylene compression fittings. Tubing is rated to 120 psi working pressure and 480 psi burst pressure. Polypropylene fittings are rated to 220 psi.

I. Electrical Panel:

1. Factory-wire the Remote I/O electrical panel mounted on the Valve Rack.
2. Provide a disconnect switch mounted on the outside of the panel to be used by the Operator to lock a train out of service for electrical maintenance without impacting the other train's ability to run (does not impact Ethernet communication).
3. The Contractor will provide no more than the following electrical connections to the Valve Rack that are needed for each membrane train:
   a. 120 Volt, single (1) phase power to the Remote I/O panel.
   b. Ethernet connection from the Master Control Panel.

2.06 FEED SYSTEM

A. Furnish equipment to create a complete, integral, and automatic feed system designed to equalize, feed and screen membrane feed water to the membrane system. All equipment is furnished loose by the Seller for installation and wiring by the Contractor. Automated valves will have solenoids mounted on the valve actuator.

B. Feed Pumps:

1. Provide two (2) duty end suction, centrifugal pumps (one (1) Feed Pump per membrane train) sized to provide the maximum flow to the membrane train. Pumps shall be in accordance with Section 43 23 89.13. Tag numbers and descriptions for the two pumps are as follows:

Equipment Description	Equipment Number
RW Feed Pump 1	P2110
RW Feed Pump 2	P2120

2. A variable speed drive shall be provided for each pump per Section 26 29 23. Seller shall have unit responsibility for coordinating the variable speed drive with the pump motor.

C. Strainers:

1. Provide two (2) duty automatic self-cleaning strainers (one (1) strainer per membrane train), to protect the membranes from particles that may cause damage. The strainer flush will occur automatically, initiated by a differential pressure set point, or by a specified time interval, whichever comes first. Tag numbers and descriptions for the two strainers are as follows:

Equipment Description	Equipment Number
RW Filter 1	FLT2115
RW Filter 2	FLT2125

2. The strainer will have a 500 micron (or better) punched hole filter of stainless steel construction, with a painted carbon steel body. Internals will be NSF approved. The gasket material will be EPDM and the lubrication will be food grade glycerin.
3. Strainer controls will be integrated into the membrane filtration system control system and will be designed to minimize loss of feed during strainer flushing, with no greater than 0.5% waste expected relative to the feed water.
4. Headloss across the strainers at the design flowrate shall not exceed 2 psi in clean condition or 5.5 psi in any condition.

D. Valves and Instrumentation:
1. Valves and Instrumentation supplied loose by the Seller for installation and wiring by the Contractor include:
a. Isolation hand valves on suction and discharge of each pump.
b. Pressure gauges on suction and discharge of each pump, with isolation valves.
c. Drain valves on suction and discharge of each pump.
d. Check valve on discharge of each pump.
e. Sample valves on discharge of each pump, to feed turbidimeter panel.
f. One (1) Feed Turbidimeter Panel with instrument, instrument auto-cleaner, isolation valve, and needle valve installed on the panel.
g. All other valve and/or instrumentation marked with a V* (indicating Vendor supplied) as shown on Sheet I-21-101.
2. Valves and instrumentation shall be in accordance with the Division 40 specifications and the applicable table found on Sheet G-00-007 provided as part of this construction package.

2.07 BACKWASH SYSTEM

A. Furnish equipment to create a complete, integral, and automatic backwash system designed to maintain and restore membrane performance. All equipment is furnished loose by the Seller for installation and wiring by the Contractor. Automated valves will have solenoids mounted on the valve actuator.

B. Design the backwash system to clean the membranes in place without requiring their disconnection from the membrane train. The backwash system shall be connected to all membrane trains and shall be designed to backwash one membrane train at a time while the other membrane train remains in operation.

C. Backwash Pumps:
1. Provide two (2) multistage vertical centrifugal pumps (duty/standby) sized for the maximum cleaning demand with all module spaces on a train filled. Pumps shall be in accordance with Section 43 23 92.02. Tag numbers and descriptions for the two pumps are as follows:

Equipment Description	Equipment Number
Membrane Backwash Pump 1	P2241
Membrane Backwash Pump 2	P2242

2. A variable speed drive shall be provided for each pump per Section 26 29 23. Seller shall have unit responsibility for coordinating the variable speed drive with the pump motor.

D. Backwash Tank:
   1. Provide one (1) Backwash Tank sized to hold sufficient permeate for two (2) backwashes, taking into account the volume for membranes with all membrane spaces filled and the Buyer's interconnecting piping, plus 20% safety factor.
   2. The Backwash Tank will have sufficient ports installed in number and size to fill with permeate, Backwash Pump inlet, overflow and drain. Each port will be fitted with an ANSI #150, gasket, and bolt style mechanical flanges.
   3. The Backwash Tank will have a port installed to allow for periodic dosing of sodium hypochlorite for biogrowth prevention in the tank.
   4. The Backwash Tank will be equipped with a top mounted vent with dust filter to allow the tank to breathe as the fluid level varies.
   5. The Backwash Tank will be equipped with a level transmitter with local display and isolation valve.
   6. Provide isolation hand valves on the tank outlet, and on the tank drain line.
   7. Backwash Tank shall be in accordance with Section 43 41 43.13 and shall have the following tag number and description:

Equipment Description	Equipment Number
Membrane Backwash Tank	T2240

E. Backwash Valves and Instrumentation:
   1. Valves and Instrumentation supplied loose by the Seller for installation and wiring by the Contractor include:
      a. One (1) Backwash flow meter.
      b. One (1) high pressure switch for membrane protection.
      c. Isolation hand valves on the suction and discharge of pump.
      d. Drain valves on suction and discharge of pump.
      e. One (1) check valve on discharge of pump.
      f. Pressure gauges on suction and discharge of pump, with isolation valves.
      g. Automatic valving that allows the Backwash Tank to be filled from common permeate header.
      h. All other valve and/or instrumentation marked with a V* (indicating Vendor (Seller) supplied) as shown on Sheet I-22-108
   2. Valves and instrumentation shall be in accordance with the Division 40 specifications and the applicable table found on Sheet G-00-007 provided as part of this construction package.

2.08 CIP SYSTEM

A. Furnish equipment to create a complete, integral, and automatic CIP system designed to maintain and restore membrane performance by reducing or controlling the transmembrane pressure. All equipment is furnished loose by the Seller for installation

and wiring by the Contractor. Automated valves will have solenoids mounted on the valve actuator.

B. Design the CIP system to clean the membranes in place without requiring their disconnection from the membrane train. The CIP system shall be connected to all membrane trains and shall be designed to clean one membrane train at a time while the other membrane train remains in operation.

C. CIP Pumps:
   1. Provide two (2) multistage vertical centrifugal pumps (duty/standby) sized for the maximum cleaning demand with all module spaces on a train filled. Pumps shall be in accordance with Section 43 23 92.02. Tag numbers and descriptions for the two pumps are as follows:

Equipment Description	Equipment Number
CIP Pump 1	P2251
CIP Pump 2	P2252

   2. A variable speed drive shall be provided for each pump per Section 26 29 23. Seller shall have unit responsibility for coordinating the variable speed drive with the pump motor.

D. CIP Tank:
   1. Provide one (1) CIP Tank sized to hold sufficient permeate for one (1) chemical clean, including neutralization and flushing volume, taking into account the volume for membranes with all membrane spaces filled, and the Buyer's interconnecting piping, plus 20% safety factor.
   2. The CIP Tank will have sufficient ports installed in number and size to fill with permeate, CIP Pump inlet, heating recirculation line, CIP mixing line, overflow and drain. Each port will be fitted with an ANSI #150, gasket, and bolt style mechanical flanges.
   3. The CIP Tank will be equipped with a top mounted vent with dust filter to allow the tank to breathe as the fluid level varies.
   4. The CIP Tank will be equipped with a level transmitter with local display and isolation valve.
   5. Provide isolation hand valves on the tank outlet, and on the tank drain line.
   6. CIP Tank shall be in accordance with Section 43 41 43.13 and shall have the following tag number and description:

Equipment Description	Equipment Number
CIP Tank	T2250

E. CIP Heater:
   1. The CIP system will include one (1) three-phase electrical heater suitable for the heating of the chemical cleaning solution to the required heated cleaning temperature (40°C), in 4 hours or less, at the minimum raw water temperature specified in Table 1. The heater will provide numerous protections to avoid overheating the solution and severely damaging piping, membranes, or tanks. These must include:

a. A dedicated heater electrical panel, with a controller to maintain the desired heater element temperature and hard wired interlocks as described below.
b. Low flow switch with hard wired interlock to ensure water is always flowing across the heater.
c. High Temperature switch with hard wired interlock.
d. Heater must be installed in a S10 316SS pipe (part of interconnecting piping supplied by the Contractor).
e. If heater is in contact with cleaning solution, it must be of a titanium alloy construction, to avoid corrosion. Ideally, the heater will not come in contact with cleaning solution, in which case it's acceptable for the heater to be of 316SS construction.
f. Heater system must include an automated drain valve to ensure heater is dry whenever not in operation in order to prevent corrosion.
g. Tag number and description for the heat is as follows:

Equipment Description	Equipment Number
CIP Heater	H2255

F. CIP Valves and Instrumentation:
1. Valves and Instrumentation supplied loose by the Seller for installation and wiring by the Contractor include:
a. One (1) CIP temperature transmitter.
b. One (1) CIP flow meter.
c. Isolation hand valves on the suction and discharge of pump.
d. Drain valves on suction and discharge of pump.
e. One (1) check valve on discharge of pump.
f. Pressure gauges on suction and discharge of pump, with isolation valves.
g. Automatic valving that allows the CIP Tank to be filled from common permeate header.
h. Automatic valving that allows CIP solution to flow to the CIP heater, returned to the CIP tank, or waste to drain.
i. All other valve and/or instrumentation marked with a V* (indicating Vendor (Seller) supplied) as shown on Sheet I-22-109
2. Valves and instrumentation shall be in accordance with the Division 40 specifications and the applicable table found on Sheet G-00-007 provided as part of this construction package.

G. CIP Dosing Pump Systems:
1. Chemical dosing systems shall be supplied for all cleaning and neutralization chemicals required by the membrane system. Supply two (2) pumps (duty/standby) for each chemical. Chemical Pumps are required for the following chemicals:
a. 12.0% Sodium Hypochlorite (10.3% as Cl2 w/w)(SHC)
b. 50.0% Liquid Citric Acid (CAS)
c. 38.0% Sodium Bisulfite (SBS)
d. 25.0% Sodium Hydroxide (SHX)

e. 50.0% Sulfuric Acid (SAS)

2. All chemical pumps shall meet the requirements outlined in Section 46 33 42.13 and shall have the following tag numbers and descriptions as follows:

Equipment Description	Equipment Number
Sodium Hypochlorite Pump 1	P2260
Sodium Hypochlorite Pump 2	P2261
Citric Acid Pump 1	P2262
Citric Acid Pump 2	P2263
Sodium Bisulfite Pump 1	P2264
Sodium Bisulfite Pump 2	P2265
Sulfuric Acid Pump 1	P2266
Sulfuric Acid Pump 2	P2267
Sodium Hydroxide Pump 1	P2268
Sodium Hydroxide Pump 2	P2269

3. Chemicals shall be pumped from a panel-mounted chemical pumping system. The Panel includes the following equipment installed and wired with interconnecting piping between the various pieces of instrumentation and valves:
   a. Two (2) duty chemical dosing pump
   b. One (1) calibration column
   c. One (1) pressure relief valve
   d. One (1) pressure gauge with diaphragm seal
   e. Lot isolation valves
   f. PVC or PVDF piping and/or tubing, selected to be chemically compatible with the cleaning chemical
   g. Electrical junction box for any solenoids, level switches, motor or other device requiring an electrical connection.
   h. All other valve and/or instrumentation marked with a V* (indicating Vendor (Seller) supplied) as shown on Sheet I-22-111 through I-22-115
4. Valves and instrumentation shall be in accordance with the Division 40 specifications and the applicable table found on Sheet G-00-007 provided as part of this construction package.

H. CIP Chemical Injection Assemblies:
   1. Chemical Injection assemblies shall be shipped loose by the Seller for Installation and wiring by the Contractor. Chemical injection assembly are to be installed on the discharge of the CIP Pumps in the Chemical Area Sumps. Each assembly shall be made of material well suited for the expected exposure for its respective cleaning/neutralization chemical. Chemical injection assemblies are required for:
      a. 12.0% Sodium Hypochlorite (10.3% as Cl2 w/w)(SHC)
      b. 50.0% Liquid Citric Acid (CAS)
      c. 38.0% Sodium Bisulfite (SBS)
      d. 25.0% Sodium Hydroxide (SHX)
      e. 50.0% Sulfuric Acid (SAS)

2. Each injection assembly must include the following equipment, to ensure predictable, consistent chemical dosing, and to avoid accidental mixing of inappropriate chemicals (such as acid and sodium hypochlorite):
    a. Two (2) isolation hand valves (one (1) located upstream, one (1) location downstream of the injection assembly) and one (1) bleed hand valve.
    b. One (1) pneumatically actuated valve for chemical dosing.
    c. One (1) check valve
    d. One (1) backpressure valve
    e. One (1) Injection Quill in accordance with Section 46 41 17.
    f. All other valve and/or instrumentation on the chemical injection lines marked with a V* (indicating Vendor (Seller) supplied) as shown on Sheet I-22-109
3. Valves and instrumentation shall be in accordance with the Division 40 specifications and the applicable table found on Sheet G-00-007 provided as part of this construction package.

I. pH/Chlorine Analyzer Panel:
1. A pH/Chlorine Analyzer Panel will be used to ensure the neutralized cleaning solution is at an acceptable pH and a low enough residual free chlorine concentration to permit discharge to sewer. The pH/Chlorine Analyzer Panel includes the following equipment installed and pre-wired on the panel with interconnecting tubing between the various pieces of instrumentation and valves:
    a. One (1) in-line chlorine sensor, complete with display, capable of measuring 5 ppm or less of free chlorine, and tolerant of up to 200 ppm of chlorine.
    b. One (1) in-line pH sensor meter to measure pH of cleaning solution during neutralization of cleaning solution waste.
    c. Flush line to ensure both sensors are in contact with water during CIP downtime.
    d. Isolation, dosing, and needle valves.
    e. All other valve and/or instrumentation on the chemical injection lines marked with a V* (indicating Vendor (Seller) supplied) as shown on Sheet I-22-110.
2. Valves and instrumentation shall be in accordance with the Division 40 specifications and the applicable table found on Sheet G-00-007 provided as part of this construction package.

2.09 BLOWER SYSTEM

A. Furnish equipment to create a complete, integral, and automatic blower system designed to air scour the membranes during backwash and sized for the maximum air demand with all module spaces on a train filled. Blowers shall be housed in an acoustical enclosure typically offed by the blower manufacture to minimize sound in process area. All equipment is furnished loose by the Seller for installation and wiring by the Contractor.

B. Two (2) duty/standby blowers shall be provided. The blowers shall conform to the following:
1. Blower Type - Positive Displacement Rotary Lobe - Oil Free
2. Manufacturer - Aerzen
3. Model - Aerzen GM Series

4. Connections - Flexible Sleeve Type Connection
5. Casing & Head Plates - Cast iron EN-GJL-200, equivalent to ASTM A48 class 30
6. Shaft - C45N, equivalent to AISI 1043
7. Rotors - Ductile iron or forge steel C45N, equivalent to AISI 1043
8. Drive - V-Belt Drive, automatic tension
9. Guard - Plate OSHA-rated V-belt drive guard
10. Control - VFD
11. Motor - TEFC 1,800 or 3,600 rpm, inverter-rated
12. Accessories (Per Each Blower) - One (1) air inlet filter, one (1) air intake/silencer, one (1) air discharge silencer, one (1) pressure relief valve, one (1) discharge pressure gauge with isolation valve, and one (1) check valve.
13. Blowers shall have the following tags and descriptions:

Equipment Description	Equipment Number
Air Blower 1	B2271
Air Blower 2	B2272

14. A variable speed drive shall be provided for each pump per Section 26 29 23. Seller shall have unit responsibility for coordinating the variable speed drive with the pump motor.

C. Blower System Valves and Instrumentation:
1. Valves and Instrumentation supplied loose by the Seller for installation and wiring by the Contractor include:
   a. One (1) Blower isolation hand valve.
   b. One (1) membrane air scour flow switch.
   c. All other valve and/or instrumentation on the chemical injection lines marked with a V* (indicating Vendor (Seller) supplied) as shown on Sheet I-22-116.
2. Valves and instrumentation shall be in accordance with the Division 40 specifications and the applicable table found on Sheet G-00-007 provided as part of this construction package.

2.10 COMPRESSED AIR SYSTEM

A. Furnish equipment to create a complete, integral, and automatic compressed air system designed to supply clean instrument air for pneumatic valve operations. The compressed air system will also provide air to the membranes for on-line MIT in the form of Pressure Decay Testing through a series of downstream filters. All equipment is sized for the maximum air demand with all module spaces on a train filled.

B. Air Compressors
1. Supply two (2) duty/standby air compressors.
2. The air compressor will meet the following specifications:
3. Manufacturer - Gardner Denver, DV Systems, or equal
4. Compressor Type - Piston (Reciprocating)
5. Maximum Pressure - Up to 175 PSIG

6. Lubrication - Pressure lubrication with Positive Displacement Oil Pump
7. Drive - Belt driven with belt guard
8. Motor - TEFC, 1,800 rpm, up to 25 HP
9. Accessories - Pressure Gauge, Safety Valve, Manual Drain Valve, Tank Discharge Valve, Enclosed Belt Guard, and Pressure Switch.
10. One compressor shall be mounted to each Air Receiver
11. Compressors shall have the following tag numbers and descriptions:

Equipment Description	Equipment Number
Air Compressor 1	C2281
Air Compressor 2	C2282

C. Air Receiver:
1. Supply two (3) air receiver tanks.
2. Manufacturer - Gardner Denver, DV Systems, or equal
3. The receiver will be free-standing, vertical, painted carbon steel construction.
4. The receiver volume will be based on the volume of air required for membrane system service air and MIT air requirements.
5. The receiver will be ASME Code Construction and will include a pressure gauge, pressure relief valve, and automatic solenoid drain valve.
6. Compressed air Receivers shall have the following tag numbers and descriptions:

Equipment Description	Equipment Number
Compressed Air Tank 1	T2281
Compressed Air Tank 2	T2282

D. Air Drier:
1. One (1) duty non-cycling refrigerated air drier will be supplied for operation with the compressor. The drier will include a condensing unit, refrigerant evaporator, mechanical separator, automatic condensate discharge valve, pre-filter, and after-filter. The drier will be equipped with filters to remove oil carryover, oil aerosols, and other particulate matter.
   a. Manufacturer: Gardner Denver, DV Systems, or equal
2. The drier capacity will be based on the volume of air required for membrane system service air and MIT air requirements.
3. The air drier will be plugged into a locally supplied electrical outlet supplied by the Contractor.
4. Compressors shall have the following tag numbers and descriptions:

Equipment Description	Equipment Number
Thermal Dryer 1	D2281
Thermal Dryer 2	D2282

E. Main Air Component Kit:
   1. Kit Includes instruments and valves to provide clean, dry instrument air to the pneumatically actuate valves. The following instruments will be supplied loose by the Seller for installation and wiring by the Contractor:
      a. One (1) primary coalescing filter, 1 micron, with auto drain
      b. One (1) pressure regulating valve.
      c. One (1) low pressure switch.
      d. One (1) low-low pressure switch.
      e. Two (2) isolation valves.
      f. One (1) manual bypass valve for maintenance.
      g. MIT Kit: Includes instruments and valve to provide clean, dry, low pressure air to the membranes for integrity testing. The following instruments will be supplied loose by the Seller for installation and wiring by the Contractor:
      h. One (1) secondary coalescing filter, 0.01 micron, with auto drain.
      i. One (1) activated carbon filter, 0.003 micron.
      j. One (1) pressure regulating valve.
      k. One (1) pressure gauge.
      l. Two (2) isolation valves.
      m. All other valve and/or instrumentation on the chemical injection lines marked with a V* (indicating Vendor (Seller) supplied) as shown on Sheet I-22-117.
   2. Valves and instrumentation shall be in accordance with the Division 40 specifications and the applicable table found on Sheet G-00-007 provided as part of this construction package.

2.11 BACKWASH QUALITY AND COAGULANT DOSING SYSTEM

A. Backwash Coagulant Dosing Pump Systems:
   1. A Backwash Coagulant dosing systems shall be supplied for injection of coagulant into the backwash water stream in the solids valve and meter vault from the chemical area in the water treatment plant. Supply two (2) pumps (duty/standby). Pumps shall be compatible with the following chemicals:
      a. Ferric Chloride
      b. Aluminum Chlorohydrate
      c. Polyaluminum Chloride
      d. High Performance Coagulant (Non-Polymer)
   2. Pumps shall meet the requirements outlined in Section 46 33 42.13 and shall have the following tag numbers and descriptions as follows:

Equipment Description	Equipment Number
Coagulant Pump 1	P2610
Coagulant Pump 2	P2620

3. Chemical shall be pumped from a panel-mounted chemical pumping system located in the Water Treatment Plant. The Panel includes the following equipment installed and wired with interconnecting piping between the various pieces of instrumentation and valves:
    a. Two (2) duty chemical dosing pump
    b. One (1) calibration column
    c. One (1) pressure relief valve
    d. One (1) pressure gauge with diaphragm seal
    e. Lot isolation valves
    f. PVC or PVDF piping and/or tubing, selected to be chemically compatible with the coagulant chemical
    g. Electrical junction box for any solenoids, level switches, motor or other device requiring an electrical connection.
    h. All other valve and/or instrumentation marked with a V* (indicating Vendor (Seller) supplied) as shown on Sheet I-26-101.
4. Valves and instrumentation shall be in accordance with the Division 40 specifications and the applicable table found on Sheet G-00-007 provided as part of this construction package.

B. Backwash Coagulant Injection Assembly:
1. The Backwash Coagulant Injection Assembly shall be shipped loose by the Seller for Installation and wiring by the Contractor. The Backwash Coagulant Injection Assembly is to be installed in the solids valve and meter vault. The assembly shall be made of material well suited for the expected exposure for its respective coagulant chemical. The possible coagulant chemicals are as follows:
    a. Ferric Chloride
    b. Aluminum Chlorohydrate
    c. Polyaluminum Chloride
    d. High Performance Coagulant (Non-Polymer)
2. The injection assembly must include the following equipment, to ensure predictable, consistent chemical dosing, and to avoid accidental mixing of inappropriate chemicals (such as acid and sodium hypochlorite):
    a. Two (2) isolation hand valves (one (1) located upstream, one (1) location downstream of the injection assembly) and one (1) bleed hand valve.
    b. One (1) check valve
    c. One (1) backpressure valve
    d. One (1) Injection Quill in accordance with Section 46 41 17.
3. Valves and instrumentation shall be in accordance with the Division 40 specifications and the applicable table found on Sheet G-00-007 provided as part of this construction package.

C. pH/Turbidity Analyzer Panel:
1. A pH/Turbidity Analyzer Panel will be used to ensure the backwash recycle water returned to the raw water tank is at an acceptable pH and is below the turbidity limit requirements outlined in Paragraph 2.02.C.2. The pH/Turbidity Analyzer Panel

includes the following equipment installed and pre-wired on the panel with interconnecting tubing between the various pieces of instrumentation and valves:

a. One (1) Feed Turbidimeter Panel with instrument, instrument auto-cleaner, isolation valve, and needle valve installed on the panel.
b. One (1) in-line pH sensor meter to measure pH of recycled backwash water.
c. Isolation, dosing, and needle valves.
d. All other valve and/or instrumentation on the chemical injection lines marked with a V* (indicating Vendor (Seller) supplied) as shown on Sheet I-26-101.

2. Valves and instrumentation shall be in accordance with the Division 40 specifications and the applicable table found on Sheet G-00-007 provided as part of this construction package.

2.12 CONTROL SYSTEM

A. A single programmable logic controller (PLC) with distributed I/O over Ethernet via Modbus TCP/IP protocol shall be provided. The PLC CPU and Ethernet communication modules will be located in the Master Control Panel (MCP), shipped loose, to be mounted in the process area. A Human-Machine Interface (HMI) will be located on the door of the MCP. Ethernet connections to the Seller's MCP and other communication nodes is by the Contractor. The MCP will also provide terminations for all non-train equipment, such as feed equipment, chemical equipment, air compressors, blowers, CIP, and Backwash equipment, and any loose shipped equipment supplied by the Seller.

B. There will be one (1) remote I/O panel per membrane train, located on the Valve Rack. This panel will provide terminations for all train specific equipment, such as the Feed pump, strainer, pneumatic and solenoid valves, mag flow meter, pressure transmitters and switches, turbidity transmitter, temperature transmitter, etc.

C. Control System: The control system shall be designed based on a distributed I/O architecture. The control system shall be based around Square D Modicon Unity platform of Programmable Logic Controllers (PLC). The control system shall include the following equipment:

1. One (1) Master Control Panel (MCP), rated NEMA 4X. The Master Control Panel (MCP), shipped loose, shall be mounted in the process area. The MCP contains the PLC. The PLC executes all control functions required for the operation of the filtration system. The control system will include a single Square D Modicon Unity PLC distributed over Ethernet via Modbus TCP/IP protocol, in combination with Schnieder Electric Harmony GTO HMI. The PLC rack will include an Ethernet module for communication to the HMI with availability for communication to the Plant SCADA system.
2. The PLC shall include a minimum of 10% spare I/O for future use. Power integrity shall be furnished via Uninterruptible Power Supply (UPS), supplied by the Contractor.
3. The MCP will include a 10" color touch screen HMI mounted in the door of the enclosure. The HMI will provide a graphical interface to the membrane filtration system process. The terminal will communicate via an Ethernet connection to the PLC. The terminal will be an Square D Modicon Unity or approved equal.
4. The MCP will include a five port industrial Ethernet switch to facilitate communication between the PLC, HMI, RAS modem, and to the plant-wide control network as required. The switch will be DIN rail mounted and be 24VDC powered.

5. To protect against lightning and transient voltage surges, each control panel will be protected at the incoming power by a transient surge suppressor located in the control panel. In addition, any discrete and analog I/O point where any part of the circuit is outside the building envelope will be individually protected by a surge suppressor.
6. A single dry relay contact will be provided for remote/auto-dialer alarming.
7. Field wiring of all the I/O to and from the control panels will be by the Contractor in accordance with wiring diagrams provided by the Seller. Unless otherwise specified, control panels will be designed primarily to accommodate field wiring entering from the bottom of the enclosure.
8. Local remote I/O panels shall be rated NEMA 4X and secured to the Valve Rack frame. The remote I/O shall communicate over Ethernet via Modbus TCP/IP protocol.

D. Programming: Provide all programming of the PLC and HMI, as to deliver a functional membrane system. Provide all I/O configuring and scaling required for the membrane system.
   1. The Seller shall be responsible for all programming for the MF PLC, database creations, and generation of all graphic display screens, alarm configurations, and trends for the HMI. The Seller shall be responsible for all PLC I/O configuration, scaling, and data exchange between the master PLC and the Treatment PLC and SCADA. The MFSS shall provide to the Owner one electronic and one hard copy of all PLC and HMI programming.
   2. All membrane system data shall be accessible from the PCS (by others) and shall be gathered directly from the master PLC and shall not be gathered from the HMI database.

E. The membrane system PLC shall be compatible for communication and integration with the Plant PLC/SCADA system.

F. Base the control architecture on a PLC located in a MCP with distributed I/O to control the membrane trains. Provide controls for all elements scope supplied. Provide all instrumentation required to control and monitor the operation of the membrane filtration system. Provide all PLC and HMI programming for all supplied equipment. Supply all software updates to control, monitor and operate the membrane filtration system.

G. To provide warranty support, Seller will require remote access to the PLC and HMI. Seller's preferred method of remote access is via a secure high-speed internet connection over Ethernet. This can be accomplished with VPN technology through the Owner's existing internet connection or through a dedicated high-speed DSL line and ISP account. The DSL line shall be supplied by the Contractor.

2.13 CONTROL OPERATION

A. All valves and control devices will be interlocked through the PLC to allow smooth and continuous automatic operation. Valves will open, close and/or modulate, depending on signals from the PLC. These signals will be predetermined through PLC programming and allow the system to operate at optimal conditions. Variable speed pumps will also be controlled by the PLC and vary their vacuum/flow output based on level signals from the process tanks.

B. All operating parameters will be continuously monitored by the PLC. If an alarm or emergency condition occurs, the PLC program will instruct the various components to change operation conditions and/or shut down the system and alert the operator. The system control logic will be designed with the ability to shut down the system in the event of an alarm condition that could be detrimental to the equipment.

2.14 HMI SYSTEM

A. The HMI will be a Schnieder Electric Harmony GTO. It will be installed on the door of the Master Control Panel. It will be programmed to provide the following features:
   1. Monitoring of the system and of individual devices.
   2. Control of the system and of individual devices.
   3. Adjustment of operating parameters.
   4. Operator and supervisor level passwords.
   5. Current alarm summary.
   6. Alarm history.

B. All monitoring, control, and alarm logic will reside in the PLC CPU. Data points defined in the CPU will be communicated over the Ethernet network via Modbus TCP/IP protocol to provide the operator monitoring and control functionality at the HMI. These data points will be available to any device on the Ethernet network, such as the Plant SCADA system (by the Contractor), to provide some or all of the operator functionality that is found on the HMI. Seller recommends that the Plant SCADA system incorporate full Operator functionality to act as a backup in the unlikely event of an HMI failure and to provide a more convenient location for operator interaction.

C. Since the Plant SCADA system will have access to the data in the Seller's PLC, features such as alarm annunciation and logging, data logging and trending, and report generation can be easily implemented on the Plant SCADA system.

2.15 HMI SOFTWARE STANDARDS

A. HMI applications will be developed using Seller's standards as described below. In general, these standards apply equally to HMI and Plant SCADA applications as the intent is to maintain a common "look and feel" regardless of platform. HMI applications will be developed to run on a Schnieder Electric Harmony GTO HMI.

B. PanelView Plus HMI screens will be developed in 800x600 pixel resolution.

C. All screens will have the following basic features:
   1. The top left corner of the screen will have the Owner's logo. For convenience, the Owner's logo will also function as a previous screen pushbutton. if the Owner's logo is not available then it will be replaced by the Seller's logo.
   2. The top right corner will have the Seller's logo.
   3. The date and time will be displayed on two lines immediately to the left of the Seller's logo.
   4. The screen title will be displayed centered at the top of the screen.
   5. Common navigation and control buttons will be located at the bottom of the screen.

6. Navigation arrows will provide a convenient means to change from one screen to another to follow the process.
7. A “screen select” pushbutton will list all the main screens that are available and will provide a convenient means to change to any screen from the current screen.
8. When a device on the screen is pressed, a popup screen will appear providing control of that device.
9. An alarm banner will pop-up when a new alarm occurs.

D. Alarms triggered by the PLC will be displayed and recorded with a date and time stamp. The Active Alarm screen will list all alarms that are currently active. The Alarm History page will list all alarms that have occurred. All alarm messages will be configured with red text on a black background. The system will be set-up to automatically delete daily log files older than two months.

E. The HMI will be configured for various security levels to ensure that users are permitted the monitoring and control functionality that they have been granted. Unless otherwise specified, there will be four (4) security levels: GUEST, OPER, SUPER, and Seller’s security level, each level having an increasing level of privileges. The system will be configured to log out the current user automatically after a pre-determined amount of time or inactivity.

2.16 ELECTRICAL

A. Junction Boxes:
1. Junction boxes to facilitate field wiring will only be supplied for skid or panel-mounted equipment where it is possible to group numerous electrical connections together in order to minimize field installation.
2. Design, supply, and installation of all other junction boxes will be by the Contractor.

B. Electrical Panel Wiring:
1. All wiring within the control panel will conform to the following standards, at a minimum:
   a. All conductors shall be copper and have 600 Volt rated insulation.
   b. Control circuit and instrument wires will be a minimum of 18AWG (max 7 Amps) and per Section 26 05 19.
   c. Power circuits (branch and feeder circuits) and bonding conductors will be a minimum of 12 AWG (max 15 Amps) and per Section 26 05 19.
   d. Wiring of all the I/O to and from the control panels to devices on the Valve Racks will be by Seller in accordance with wiring diagrams.
   e. Control panels will be designed primarily to accommodate field wiring entering from the bottom of the enclosure.

C. Field Device Wiring:
1. Factory Field device wiring within the boundaries of the Valve Rack conforms to NFPA 70 National Electrical Code.
   a. All conductors shall be copper and have 600 Volt rated insulation.
2. Instrument Cables are generally shielded multiconductor type with 300 Volt insulation minimum and will be certified to conform to Section 26 05 19.

3. Low voltage multiconductor cables to field devices within the Valve Rack boundary are routed in a central cable tray internal to the skid.
4. Field devices within the Valve Rack boundary requiring 120VAC power are wired using liquid-tight flexible conduit.
5. Wiring of all the field-mounted instrumentation I/O to and from the membrane filtration system panels will be by the Buyer in accordance with wiring diagrams provided by the Seller.

2.17 SPECIAL TOOLS

A. Furnish all special tools required for routine operation of the membrane filtration system. Special tools include but are not limited to the following:
   1. One (1) membrane repair kit.
   2. Two (2) flange plates to blank off an individual module.
   3. Two (2) slings for transporting modules during installation.

PART 3 EXECUTION

3.01 DESIGN ASSISTANCE

A. Provide assistance to the Engineer during the Submittal phase of the project. Design assistance will include the following:
   1. Attend Design Conferences: Allow minimum of two (2) hours per design conference. Design Conferences are to be virtual meetings (i.e.: not in-person) and must include the following personnel, at a minimum, from the Seller's project team: Project Manager, Project Lead Engineer, Process Engineer.
      a. Preliminary Design Conference: to be held within twenty (20) days of the Effective Date of Agreement to introduce the project and project team.
      b. Design Review Conference: to be held following Submittal 1 receipt by Engineer to review the design.
      c. Subsequent Design Review Conference: to be held following Submittal 4 receipt by the Engineer for continued review of the design.
      d. Conduct one (1) additional design review conference at Engineer's request, during the submittal process.
      e. Conduct a minimum of two (2) design coordination conferences at Engineer's request following final submittals.
   2. Provide the Submittals described in these Specifications. Format for supply is electronic copy only.
   3. Review Engineer's design details and examine procedures for ensuring quality of membrane filtration design.

3.02 PREINSTALLATION MEETING

A. Preinstallation Conference: Attend conference prior to shipment and scheduled with Engineer and Contractor. Allow minimum of two (2) hours. Preinstallation Conference is to be a virtual meeting (i.e.: not in-person).
   1. Require representatives of each entity directly concerned with membrane filtration units to attend.

2. Review construction details and examine procedures for ensuring quality of membrane filtration installation.

3.03 FACTORY TESTING OF MEMBRANE MODULES AND HOUSINGS

A. Prior to delivery, all the membranes and housings will be individually tested and permanently marked with factory serial number. A test report will be submitted to the Buyer through the Engineer prior to membrane delivery. The test report will provide the following:
   1. Membrane Serial Number.
   2. Date of Test.
   3. Test Conditions.
   4. Test Results.

3.04 STARTUP, COMMISSIONING, AND OPERATOR TRAINING

A. Seller will provide a minimum of 35 days of services as specified below, allocated across the specific number of trips to site included. Additional trips and time on site can be discussed further with the Buyer to suit project and site considerations, at additional cost.

Table 4: Start-Up, Commissioning, and Operator Training Requirements

# Trips	Minimum Days On-Site	General Scope of Work / Description
1	2	Pre-start-up Inspection Visit: Seller will provide time to inspect installation work, address questions, assist Contractor in development of punch list of completion items necessary prior to return visit, and provide guidance on module installation.
2	30	System Commissioning including: - Electrical and mechanical checkouts - Membrane installation verification - Controls testing including integration - Process start-up
1	3	Operator Training: Seller will provide formal training that will take place prior to the Performance Test.
Total: 4	Total: 35	- Seller will additionally include for travel time to and from the job site for Seller's Field Service personnel. - Travel/living expenses will be also included by the Seller. - Seller will assume an 8-hr workday and no weekends or holidays are required. - The Buyer will provide the Seller a minimum of two weeks' advance notice to schedule all trips to site.

3.05 PERFORMANCE TEST

A. The Performance Test shall not commence until all system commissioning requirements have been completed including, but not limited to pressure/leakage tests, instrumentation tests and adjustments, electrical and mechanical check-outs, controls testing, and system disinfection. Operator Training should also be complete prior to the commencement of the Performance Test.

1. Pre-requisites: The Performance Test shall not begin until after final approval and submittal of the IOM Manual and submittal and approval of a Performance Test Plan. Allow fourteen (14) days prior to the day the Performance Test is scheduled to begin.
2. The Performance Test is designed to demonstrate the proper operation of all equipment. During the Performance Test, at least one (1) membrane train shall be operated at nominal flow to demonstrate the system complies with the water quality objectives set forth in this specification.
3. The Performance Test shall be conducted over thirty (30) days. The Buyer will afford Seller full access to the system and to all operating data pertaining to system performance until discharge of the latter's obligations hereunder. The Performance Test will be conducted by the Buyer, with technical assistance from the Seller, in accordance with mutually agreeable applicable standard techniques and operating procedures specified by Seller in the Installation, Operations and Maintenance Manual.
4. Technical assistance from the Seller is virtual (i.e. not in-person). The Seller's representative will be knowledgeable with the equipment and systems and will be expected to effectively interface with the Contractor, the Engineer and Owner during troubleshooting activities (electrical, I&C, SCADA, mechanical) that may arise during the Performance Test. The Owner will furnish the power and chemicals required for normal operation of the membrane system during the Performance Test period.
5. During the Performance Test the membrane system will demonstrate the performance criteria per the production capacity specified and permeate water quality specified. The proposed performance criteria will be met on a daily basis calculated as an arithmetic mean of values over a 24-hour period (midnight to midnight).
6. The Performance Test shall be deemed successful if membrane trains operate continuously for the full duration of the test at design flow without requiring a Recovery Clean. Interruption of operation not attributable to the Seller (power outage, absence of feed water, etc.) will not cause the Performance Test to be re-started. The Owner will bear the cost of additional expenses incurred by the Seller due to these interruptions.

3.06 SELLER'S RESPONSIBILITIES FOLLOWING SUBSTANTIAL COMPLETION

A. Following Substantial Completion, the Seller will provide the following services: (Unless specifically noted below, the costs for these services are included in the lump sum price for the membrane system.)
   1. Monitoring of Membrane Performance: Operating information will be transmitted to the Seller for ongoing monitoring of the membrane filtration system performance. Seller will maintain continuing data logging for performance monitoring, support, and warranty maintenance purposes. Seller will provide recommendations for operation and maintenance on an as-needed basis, with biweekly reports (minimum) during the first year. Reports will include performance curves and recommendations for improvements.
   2. Emergency Support Services: Telephone Assistance - Provide 24-hour per day, seven-day per week support for one (1) year for troubleshooting assistance by technical support specialists.

3.07 WORK BY CONTRACTOR

A. It is the Contractor's responsibility to coordinate with the Seller to ensure that all required equipment is provided and installed correctly. The following items are to be supplied by the Contractor and include, but are not limited to:

1. Unloading and temporary storage, if necessary, of delivered equipment at a mutually agreed point. The storage facility will meet the Seller's storage requirements.
2. Equipment installation according to Seller-provided instructions.
3. Installation of all membrane modules.
4. Submittal, purchase and installation of all other equipment specified by the Engineer to complete the system, such as, but not limited to: air release valves on all high points in the interconnecting piping, motor control center (MCC) with VFDs and motor starters for the membrane system equipment, Uninterruptible Power Supply (UPS) for the Master Control Panel, and chemical feed facilities including chemical tanks.
5. All chemical storage and delivery systems for membrane system equipment, as required.
6. All applicable civil design and works, including any building, site preparation, grading, excavations, foundations and trenches and accessories, etc.
7. Stamping, signing, or sealing of general drawings as per Federal, State, or local regulations or codes.
8. Provide all access structures (scaffolding) and mechanical lifting equipment (cranes, forklifts, and scissor lifts).
9. Interconnecting piping from Seller's termination point, generally considered to be the terminus (edge) of each Seller supplied Valve Rack, suction or discharge flange of pumps, blowers, compressors, etc. and any other loose shipped equipment
10. Interconnecting conduit, wiring, etc. from each equipment item termination point identified by the Seller's shop drawings.
11. Laboratory services during equipment check-out, start-up, and testing.
12. Flushing and disinfection of all piping and disposal of membrane preservative.
13. All site utilities such as potable water lines, waste lines, chemicals, and power required for operation of the system.
14. Supply and installation of all required oil and lubrication for equipment start-up and initial operations as per the manufacturer's literature for the specific piece of equipment.
15. Design, supply, and installation of equipment anchor bolts.
16. Field alignment of all pumps and blowers supplied by the Seller.
17. Safety and Environmental related equipment, supplies, testing and training. The Buyer will provide training to Seller's personnel on all relevant and standard company operating procedures and practices for performing work on site. Such training programs may include, but are not limited to, general environmental health and Safety (EHS), HAZOP, fire protection, drug testing, incident notice, site conduct, standard first aid, chemical receiving, electrical safety, etc. Buyer will provide a certificate of training for Seller's personnel. This program will be fully documented, training materials will be provided, and attendance list will be kept.
18. All easements, licenses and permits required by governmental or regulatory authorities in connection with the supply, erection, and operation of the system.

19. Level signal from Buyer's Clearwell and upstream equipment, as applicable.
20. Plant SCADA and integration of the Seller's control system with the Plant SCADA.
21. Configuration of instrument and PLC signals from the water treatment system to the Plant PLC or DCS.
22. Supply of telephone/fax/modem access while Seller's staff members are on-site.
23. All analytical testing during start up and the Performance Test.
24. Chemical storage (day/bulk tanks) as required.
25. System operation during the Performance Test.

END OF SECTION