Navajo Nation
Western Navajo Pipeline Phase 1

PROJECT MANUAL

CAMERON BOOSTER PUMP STATIONS AND PRESSURE REDUCING VALVE STATIONS

VOLUME 2 OF 2

DIVISIONS 1 THRU 17 – TECHNICAL SPECIFICATIONS

Bid Issue

Navajo Tribal Utility Authority

USDA-RD AZ

January 2025

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

PROJECT MANUAL

FOR CONSTRUCTION OF

Navajo Nation
WESTERN NAVAJO PIPELINE PHASE 1

CAMERON BOOSTER PUMP STATIONS AND PRESSURE REDUCING VALVES

Volume 2 of 2
Divisions 1 thru 17 – Technical Specifications

Bid Issue

Prepared by:

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Project No. 143956

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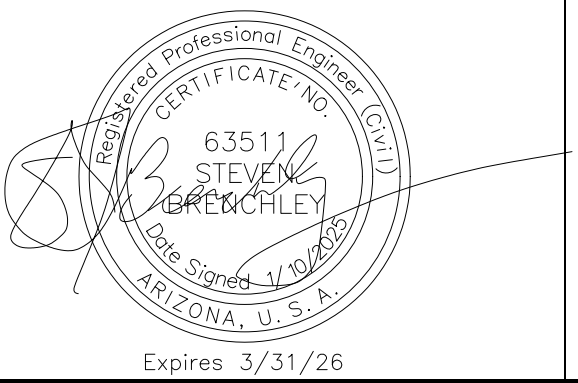
SECTION 00016

SEALS PAGE

WESTERN NAVAJO PIPELINE PHASE 1

CAMERON BOOSTER PUMP STATIONS AND PRESSURE REDUCING VALVE STATIONS

CONTRACT: BOOSTER PUMP STATIONS AND PRESSURE REDUCING VALVES

ITEMS IN THIS PROJECT MANUAL	PREPARED BY
Divisions 1 – 2, 9, 10 (10441),11,15	
 Expires 3/31/26	Steve Brenchley, P.E. Brown and Caldwell 6975 Union Park Center, Suite 490 Midvale, UT 84047
Divisions 1 (01410, 01900), 3,4, 5, 9	
	Jonathan F. Harper Brown and Caldwell 6500 SW Macadam Avenue, Suite 200 Portland, OR 97239

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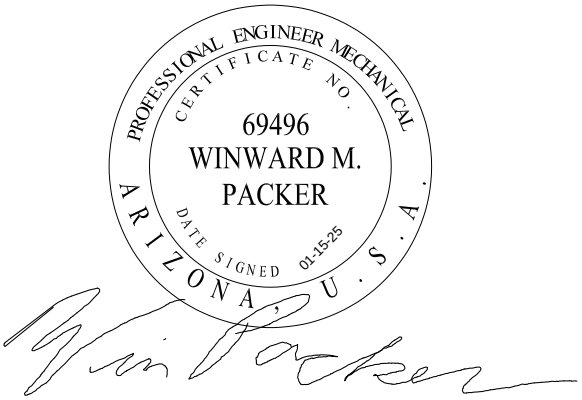	Win Packer, P.E. WHW Engineering LLC. 8619 Sandy Pkwy, Unit 101 Sandy, UT 84070
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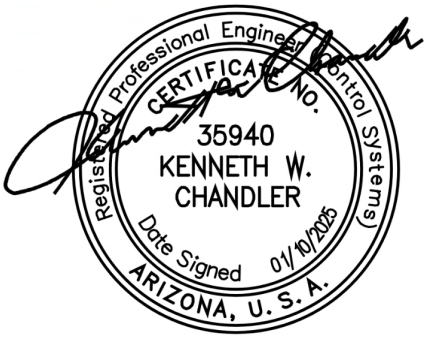
Division 17	
	Ken Chandler, P.E. Brown and Caldwell 2 N. Central Avenue, Suite 1600 Phoenix, AZ 85004

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Navajo Nation
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

CAMERON PUMP STATIONS AND PRESSURE RELIEF VALVES

DIVISION 1

GENERAL REQUIREMENTS

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SECTION 01010

SUMMARY OF WORK

1.0 GENERAL

The work covered under this contract will be performed at multiple sites of the Bodaway-Gap and Cameron Community Water Systems operated by the Navajo Tribal Utility Authority.

2.0 DESCRIPTION OF OWNER'S PROJECT

The overall project will provide additional water supply to the Cameron Water System by adding a new pump station and replacing six pressure reducing valves. Two small pump stations are also required to lift water to higher elevations along the distribution pipe between Bodaway-Gap and Cameron.

3.0 WORK OF THIS CONTRACT

The work to be performed under this contract includes:

- Construction of a new pump station with capacity of 160 gpm and pump house with new electrical and telemetry controls system.
- Construction of six 2-inch by 4-inch pressure reducing valve with vaults to replace existing six ¾-inch by 2-inch pressure reducing valves and vaults.
- Construct two small pump stations with capacity of 30 and 35 gpm with precast pump house.
- Limiting existing water outages to existing water users to minimum possible outage time. Contractor is required to notify all existing water users when and how long outages will occur.

4.0 WORK OF OTHER CONTRACTS – NOT NEEDED

5.0 CLARIFICATIONS REGARDING THE WORK

- The Contractor is advised that the Work includes everything in the Project Manual and on the Drawings.

END OF SECTION

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SECTION 01014

WORK SEQUENCE

PART 1--GENERAL

1.01 CONTINUITY OF SYSTEM OPERATIONS

A. GENERAL:

The existing Cameron water system is currently and continuously receiving potable water from Bodaway-Gap, 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 SEQUENCE AND SCHEDULE OF CONSTRUCTION

A. General:

1. To permit continuous production and disinfection of water and compliance with water quality requirements, the construction schedule shall provide for the following specific conditions:

    a. Installation and modification of various control systems within this project will not impact system and not require temporary partial shutdown of these systems. Works shall be planned and scheduled in advance in order to minimize downtime.

2. To facilitate the required temporary modifications to allow production and treatment operations to continue during construction of the work of this project, the Contractor shall coordinate with the Owner and Engineer

B. To permit potable water system operation and disinfection, the construction schedule required in in the General Conditions or Section 01310 of the Contract Documents shall provide for the following specific conditions.

C. Existing Cameron System.

1. Potable water is produced by existing Bodaway-Gap Wells 1 and 2, and delivered to the Gap Tank.

2. Bodaway-Gap Well 1 and 2 are chlorinated at Well 2 pumphouse.

3. The existing Gap Tank Telemetry PLC provides tank level information for

start/stop and chlorinator control to the two Wells.

4. Potable water is distributed to Cameron by gravity from Gap Tank to Cameron Tank. The distribution of water to Cameron shall maintain operation.

5. The Contractor shall propose and submit any required well, tank, piping, telemetry, or other process outage plans required.

D. New Pump Stations

1. The Boosterpaq and piping at all three stations shall be tested, disinfected, and made operational prior to modification of the system and telemetry operation. An approval for disinfection shall be obtained prior to the disinfection process.

2. All new pressure relief valves shall be operational prior to start-up of Pump Station No. 1

3. Booster Pump Station No. 1 Telemetry PLC shall obtain tank level information from the existing Cameron Tank and provide start/stop control of Booster Pump Station No. 1.

4. Booster Pump Station No. 2 and 3 shall obtain pressure information from system to provide start/stop control of Boosterpaq pumps.

E. Pressure Reducing Valves

1. The pressure reducing valves and piping shall be tested, disinfected, and made operational prior to modification of system. An approval for disinfection shall be obtained prior to the disinfection process.

2. The existing pressure reducing valve stations shall remain in operation throughout the remainder of the work and decommissioned when the new pressure valve stations are ready for operation.

1.03 SUBMITTALS

The following submittals shall be provided in accordance with Section 01300:

A. OUTAGE PLAN:

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. Submit a detailed outage plan and time schedule for operations which will make it necessary to remove any facility, piping, well, electrical or control circuit, or equipment 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. The detailed plan shall describe the means and methods to maintain potable water system operational and disinfected, the length of time required to complete said operation, and the necessary personnel and equipment which the Contractor shall provide in order to prevent extended duration loss of available potable water.

PART 2—PRODUCTS – NOT USED

PART 3—EXECUTION – NOT USED

END OF SECTION

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SECTION 01046

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 01014.

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 and piping alterations in accordance with the requirements herein specified. Six (6) existing Pressure Reducing Valve (PRV) stations are to be demolished after their replacements have been installed and are operational.

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 their 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.

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.

PART 2 PRODUCTS

2.01 REPAIR AND RESTORATION – NOT USED

2.02 PENETRATIONS – NOT USED

2.03 MODIFICATIONS OF EXISTING STRUCTURES – NOT USED

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 01560. In addition, Contractor shall enforce the following safety requirements:
   1. No fires will be permitted on-site.

3.02 DEMOLITION OF EXISTING STRUCTURES – NOT USED

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

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SECTION 01050

SURVEY INFORMATION

Reference benchmarks and baselines are as specified in the Survey Drawings. 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, stakes for pipe locations and other working points, lines, and elevations. 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 their operations at no cost to the Owner.

END OF SECTION

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SECTION 01071

STANDARD REFERENCES

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

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

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
ASE Code	American Standard Safety Code for Elevators, Dumbwaiter and Escalators American National Standards Institute 1430 Broadway New York, NY 10018
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 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
CALTEST	Materials Manual, State of California, Business and Transportation Agency Department of Public Works State of California, Department of Transportation 6002 Folsom Boulevard Sacramento, CA 95819
CALTRANS	Standard Specifications, State of California, Department of Transportation State of California, Business and Transportation Agency P.O. Box 1499 Sacramento, CA 95807
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
CSA	Canadian Standards Association 178 Rexdale Boulevard Rexdale, Ontario, M9W IR3, Canada
DEMA	Diesel Engine Manufacturer's Association 30200 Detroit Road Cleveland, OH 44145
DHI	Door and Hardware Institute 14170 Newbrook Drive Chantilly, VA 22021

DIS	Division of Industrial Safety California Department of Industrial Relations 2422 Arden Way Sacramento, CA 95825
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
ESO	Electrical Safety Orders California Administrative Code, Title 8, Chap. 4, Subarticle 5 Office of Procurement, Publications Section P.O. Box 20191 8141 Elder Creek Road Sacramento, CA 95820
FEDSPEC	Federal Specifications General Services Administration Specification and Consumer Information Distribution Branch Washington Navy Yard, Bldg. 197 Washington, DC 20407
FEDSTDS	Federal Standards (see FEDSPECS)
FM	Factory Mutual Engineering and Research Corporation 1151 Boston-Providence Turnpike P.O. Box 9102 Norwood, MA 02062
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

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	Instrument Society of America 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
MILSPEC	Military Specifications Naval Publications and Forms Center 5801 Tabor Avenue Philadelphia, PA 19120
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
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 02269
NELMA	Northeastern Lumber Manufacturers Association, Inc. P.O. Box 87A Cumberland Center, ME 04021

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 02269
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
RIS	Redwood Inspection Service California Redwood Association 405 Enfrente Dr., Suite 200 Novato, CA 94949
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
SBCCI	Southern Building Code Congress International Inc. 900 Montclair Road Birmingham, AL 35213
SCMA	Southern Cypress Manufacturers Association 400 Penn Center Boulevard, Suite 530 Pittsburg, PA 15235
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

USBR Bureau of Reclamation
U.S. Department of Interior
Engineering and Research Center
Denver Federal Center, Building 67
Denver, CO 80225

WCLIB West Coast Lumber Inspection Bureau
6980 SW Varns St.
P.O. Box 23145
Portland, OR 97223

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

SECTION 01150

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

PART 1 GENERAL

1.01 SCOPE

The method of measurement and basis of payment is described in Article 1.04 of this section.

1.02 GENERAL

The total bid price for each item of the contract shall cover all Work, shown on the Drawings and required by the Specifications and other Contract Documents. All costs in connection with the Work, including furnishing all materials, equipment, supplies and appurtenances; providing all construction plant, equipment, and tools; performing all necessary labor and supervision to fully complete the Work; shall be included in the unit and lump sum bid prices. No item required by the Contract Documents for the proper and successful completion of the Work will be paid for outside of or in addition to the prices submitted in the bid. All work not specifically set forth as a pay item in the Bid Form shall be considered a subsidiary obligation of the CONTRACTOR and all costs in connection therewith shall be included in the prices bid.

1.03 ESTIMATED QUANTITIES

All estimated quantities stipulated in the Bid Form or other Contract Documents are approximate and are to be used only (a) as a basis for estimating the probable cost of the Work and (b) for the purpose of comparing the bids submitted for the Work. The actual amounts of work done and materials furnished under unit price items may differ from the estimated quantities. The basis of payment for work and materials will be the actual amount of work done and materials furnished. The CONTRACTOR agrees that they will make no claim for damages, anticipated profits, or otherwise on account of any difference between the amounts of work actually performed and materials actually furnished and the estimated amounts herein accept as follows. Either the OWNER or the CONTRACTOR may demand in writing that a supplemental agreement or change order be prepared to authorize an adjustment in the unit price of any major contract item if the quantity of said major contract item increases or decreases by more than 25 percent from that shown in the Contract Documents. A major contract item is defined as any item having an original contract value in excess of 10 percent of the total original contract.

1.04 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Trench Excavation, Bedding, Bedding Gravel, Compaction, Backfilling and Surface Restoration, Clearing and Grubbing. There will not be any separate measurement and payment for structural excavation, compaction and backfilling, bedding, gravel or asphalt surface restoration, traffic control, dewatering, sheeting, or shoring, clearing and grubbing, but they shall be considered subsidiary to associated bid items. The pipe installation; trench excavation, haul, compaction,

water, backfilling, surface restoration, sheeting, or shoring will not be measured and paid separately and shall be included in the unit price of PVC and HDPE pipe unless otherwise noted herein. Likewise, all locating, crossing, protecting and coordination relating to privately owned buried utilities shall be included in the appropriate bid prices. Additional greater bury depth of up to 8 feet to the top of the pipe, in order to avoid creating a high point in the pipe is also subsidiary.

A. MOBILIZATION/DEMOBILIZATION: ITEM A1:

Measurement for this item will be lump sum with payment made for mobilization to cover the costs of preparatory work and operations, including but not limited to those necessary for the movement of personnel, equipment, supplies, materials and incidentals to the project site; for the establishment of all offices, supervision and compliance with safety regulations, staging areas and revegetation of these areas, utilities buildings and other facilities necessary for the Work on the project and for all other work and operations which must be performed or cost incurred including final cleanup and moving off of project site upon completion of Work.

Mobilization costs for subcontracted work shall be considered included. Also included are the costs for any permits and fees.

B. CONTRACT BOND AND INSURANCE: ITEM A2:

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.

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:

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.

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).

C. GENERAL REQUIREMENTS: ITEM A3:

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.

D. BOOSTER PUMP STATION NO. 1 SITE/CIVIL: ITEM B1

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:

- Includes clearing & grubbing, topsoil stripping, cut, engineered fill, excavation, shoring and bracing, haul, dewatering, backfill, compaction, surface restoration, topsoil replacement and seeding, erosion control blanket, locating and crossing all adjacent utilities as well as final grading and reclamation.
- Access/parking area – grading, subgrade preparation, compaction, exterior concrete, furnishing and placing the crushed base surfacing, bluetopping (if necessary).
- Also included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

E. BOOSTER PUMP STATION NO. 1 YARD PIPING: ITEM B2

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:

- All pipe necessary for the completion of the structure, the suction and discharge piping to the transition couplings outside of the building, including these couplings; tees, bends, flexible couplings, valves between the couplings, connection to existing pipe system, restrained joint fittings and concrete encasement.
- Drain piping, drainage infiltrators, flush line, bends, valves, and tees.
- Also included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

F. BOOSTER PUMP STATION NO. 1 8'- CHAIN LINK FENCE: ITEM B3

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:

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

G. BOOSTER PUMP STATION NO. 1 PUMP HOUSE BUILDING: ITEM B4

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:

- The complete CMU building setting, as well as the building and all of its components including the walls, window, concrete, roof, doors, door hardware, and all other accessories, fasteners, and appurtenances required for the satisfactory installation.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

H. BOOSTER PUMP STATION NO. 1 PUMP HOUSE MECHANICAL: ITEM B5

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:

- Testing, flushing and disinfection of pump house piping and appurtenances.
- All associated piping and pipe spools; pressure gauges, pressure transducers, Boosterpaq pump, check valves, isolation valves, temperature switches, and pump mounting structure; pressure switches, ball valves, hose bibs, flange adaptors, pipe stands and supports; the air/vac valve with isolation valve, and the magnetic flow meter; as well all other accessories, fasteners, and appurtenances required for the satisfactory installation.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

I. BOOSTER PUMP STATION NO. 1 PUMP HOUSE HVAC: ITEM B6

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:

- HVAC components and all other accessories, fasteners, and appurtenances required for the satisfactory installation.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

J. BOOSTER PUMP STATION NO. 1 PUMP HOUSE ELECTRICAL & CONTROLS: ITEM B7

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:

- Connection to the Boosterpaq pump and motor to include: the pumping system with motors, temperature switches, as well as the check out, startup and training on the pumps and controls, and providing O&M manuals and factory certifications.
- Furnishing and installing all electrical and controls components associated with this building including SCADA panels and antennas; and coordination with and connection to the local electrical utility.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

K. BOOSTER PUMP STATION NO. 2 SITE/CIVIL: ITEM C1

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:

- All topsoil stripping, excavation, shoring and bracing, haul, dewatering, backfill, compaction, surface restoration, topsoil replacement and seeding, erosion control blanket, locating and crossing all adjacent utilities as well as final grading and reclamation.
- Access/parking area – grading, subgrade preparation, compaction, furnishing and placing the crushed base surfacing, bluetopping (if necessary), exterior concrete.
- Also included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

L. BOOSTER PUMP STATION NO. 2 YARD PIPING: ITEM C2

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:

- All pipe necessary for the completion of the structure, the suction and discharge piping to the transition couplings outside of the building, including these couplings; tees, bends, flexible couplings, valves between the couplings, connection to existing pipe system, restrained joint fittings and concrete encasement.
- Drain piping, drainage infiltrators, flush line, bends, valves, and tees.
- Also included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

M. BOOSTER PUMP STATION NO. 2 8'-CHAIN LINK FENCE: ITEM C3

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:

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

N. BOOSTER PUMP STATION NO. 2 PREFABRICATED PUMP HOUSE: ITEM C4

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:

- The complete precast building setting, all of its components including the walls, roof, doors, door hardware, HVAC components and all other accessories, fasteners, and appurtenances required for the satisfactory installation.
- Also included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

O. BOOSTER PUMP STATION NO. 2 PUMP HOUSE MECHANICAL: ITEM C5

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:

- All associated piping and pipe spools; pressure gauges, pressure transducers, pressure switches, ball valves, hose bibs, flange adaptors, pipe stands and supports; the air/vac valve with isolation valve, and the magnetic flow meter.
- Boosterpaq pumps, check valves, isolation valves, temperature switches, and pump mounting structure.
- Testing, flushing and disinfection of pump house piping and appurtenances.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

P. BOOSTER PUMP STATION NO. 2 PUMP HOUSE ELECTRICAL & CONTROLS: ITEM C6

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:

- Connection to the Boosterpaq pump and motor to include: the pumping system with motors, as well as the check out, startup and training on the pumps and controls, and providing O&M manuals and factory certifications.
- Furnishing and installing all electrical and controls components associated with this building including SCADA panels and antennas; and coordination with and connection to the local electrical utility.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

Q. BOOSTER PUMP STATION NO. 3 SITE/CIVIL: ITEM D1

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:

- All topsoil stripping, excavation, shoring and bracing, haul, dewatering, backfill, compaction, surface restoration, topsoil replacement and seeding, erosion control blanket, locating and crossing all adjacent utilities as well as final grading and reclamation.
- Access/parking area – grading, subgrade preparation, compaction, furnishing and placing the crushed base surfacing, bluetopping (if necessary), exterior concrete.
- Also included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

R. BOOSTER PUMP STATION NO. 3 YARD PIPING: ITEM D2

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:

- All pipe necessary for the completion of the structure, the suction and discharge piping to the transition couplings outside of the building, including these couplings; tees, bends, flexible couplings, valves between the couplings, connection to existing pipe system, restrained joint fittings and concrete encasement.
- Drain piping, drainage infiltrators, flush line, bends, valves, and tees.
- Also included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

S. BOOSTER PUMP STATION NO. 3 8'-CHAIN LINK FENCE: ITEM D3

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:

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

T. BOOSTER PUMP STATION NO. 3 PREFABRICATED PUMP HOUSE: ITEM D4

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:

- The complete precast building setting, all of its components including the walls, roof, doors, door hardware, HVAC components and all other accessories, fasteners, and appurtenances required for the satisfactory installation.
- Also included are any other work, materials, tools, equipment, erosion protection, labor or other incidentals necessary to complete this item.

U. BOOSTER PUMP STATION NO. 3 PUMP HOUSE MECHANICAL: ITEM D5

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:

- All associated piping and pipe spools; pressure gauges, pressure transducers, pressure switches, ball valves, hose bibs, flange adaptors, pipe stands and supports; the air/vac valve with isolation valve, and the magnetic flow meter.
- Boosterpaq pumps, check valves, isolation valves, temperature switches, and pump mounting structure.
- Testing, flushing and disinfection of pump house piping and appurtenances.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

V. BOOSTER PUMP STATION NO. 3 PUMP HOUSE ELECTRICAL & CONTROLS: ITEM D6

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:

- Connection to the Boosterpaq pump and motor to include: the pumping system with motors, as well as the check out, startup and training on the pumps and controls, and providing O&M manuals and factory certifications.
- Furnishing and installing all electrical and controls components associated with this building including SCADA panels and antennas; and coordination with and connection to the local electrical utility.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

W. PRESSURE REDUCING VALVE STATION NO. 1 SITE/CIVIL: ITEM E1

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. Price shall include all trench excavation to depths indicated, bedding/backfill; traffic control; shoring, dewatering, all surface restoration, and compaction.

X. PRESSURE REDUCING VALVE STATION NO. 1 VAULT: ITEM E2

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. Price shall include the precast pressure reducing valve vault (9-ft x 6-ft x 6-ft) with hatch, ladder, and all other accessories, fasteners, and appurtenances required for the satisfactory installation. Also included are any work, materials, tools, equipment, labor or incidentals necessary to complete this item.

Y. PRESSURE REDUCING VALVE STATION NO. 1 VALVE ASSEMBLY: ITEM E3

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:

- Includes pressure reducing valves, piping with fittings, air release valves, gate valves, valve boxes, check valve, pressure gauges, saddle, curb stop and corporation stop valves, and appurtenances for complete installation.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

Z. PRESSURE REDUCING VALVE STATION NO. 1 EXISTING PIPE CONNECTION: ITEM E4

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:

- Includes connection to existing 6-inch PVC pipeline to include piping, valves, valve boxes, flush valve, assemblies, fittings, to and from PRV Vault.
- Thrust blocking, restrained joints if necessary, testing and disinfection; furnishing and installing the materials; marker posts (marked accordingly) and all materials.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

AA. PRESSURE REDUCING VALVE STATION NO. 1 DEMOLITION: ITEM E5

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:

- Abandon existing vault in place and remove all piping & appurtenances.
- Remove valve boxes and above ground piping.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

BB. PRESSURE REDUCING VALVE STATION NO. 2 SITE/CIVIL: ITEM F1

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. Price shall include all trench excavation to depths

indicated, bedding/backfill; traffic control; shoring, dewatering, all surface restoration, and compaction.

CC. PRESSURE REDUCING VALVE STATION NO. 2 VAULT: ITEM F2

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. Price shall include the precast pressure reducing valve vault (9-ft x 6-ft x 6-ft) with hatch, ladder, and all other accessories, fasteners, and appurtenances required for the satisfactory installation. Also included are any work, materials, tools, equipment, labor or incidentals necessary to complete this item.

DD. PRESSURE REDUCING VALVE STATION NO. 2 VALVE ASSEMBLY: ITEM F3

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:

- Includes pressure reducing valves, piping with fittings, air release valves, gate valves, valve boxes, check valve, pressure gauges, saddle, curb stop and corporation stop valves, and appurtenances for complete installation.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

EE. PRESSURE REDUCING VALVE STATION NO. 2 EXISTING PIPE CONNECTION: ITEMS F4

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:

- Includes connection to existing 6-inch PVC pipeline to include piping, valves, valve boxes, flush valve, assemblies, fittings, to and from PRV Vault.
- Thrust blocking, restrained joints if necessary, testing and disinfection; furnishing and installing the materials; marker posts (marked accordingly) and all materials.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

FF. PRESSURE REDUCING VALVE STATION NO. 2 DEMOLITION: ITEM F5

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:

- Abandon existing vault in place and remove all piping & appurtenances.
- Remove valve boxes and above ground piping.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

GG. PRESSURE REDUCING VALVE STATION NO. 3 SITE/CIVIL: ITEM G1

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. Price shall include all trench excavation to depths indicated, bedding/backfill; traffic control; shoring, dewatering, all surface restoration, and compaction.

HH. PRESSURE REDUCING VALVE STATION NO. 3 VAULT: ITEM G2

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. Price shall include the precast pressure reducing valve vault (9-ft x 6-ft x 6-ft) with hatch, ladder, and all other accessories, fasteners, and appurtenances required for the satisfactory installation. Also included are any work, materials, tools, equipment, labor or incidentals necessary to complete this item.

II. PRESSURE REDUCING VALVE STATION NO. 3 VALVE ASSEMBLY: ITEM G3

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:

- Includes pressure reducing valves, piping with fittings, air release valves, gate valves, valve boxes, check valve, pressure gauges, saddle, curb stop and corporation stop valves, and appurtenances for complete installation.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

JJ. PRESSURE REDUCING VALVE STATION NO. 3 EXISTING PIPE CONNECTION: ITEMS G4

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:

- Includes connection to existing 6-inch PVC pipeline to include piping, valves, valve boxes, flush valve, assemblies, fittings, to and from PRV Vault.
- Thrust blocking, restrained joints if necessary, testing and disinfection; furnishing and installing the materials; marker posts (marked accordingly) and all materials.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

KK. PRESSURE REDUCING VALVE STATION NO. 3 DEMOLITION: ITEM G5

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:

- Abandon existing vault in place and remove all piping & appurtenances.
- Remove valve boxes and above ground piping.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

GG. PRESSURE REDUCING VALVE STATION NO. 4 SITE/CIVIL: ITEM H1

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. Price shall include all trench excavation to depths indicated, bedding/backfill; traffic control; shoring, dewatering, all surface restoration, and compaction.

HH. PRESSURE REDUCING VALVE STATION NO. 4 VAULT: ITEM H2

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. Price shall include the precast pressure reducing valve vault (9-ft x 6-ft x 6-ft) with hatch, ladder, and all other accessories, fasteners, and appurtenances required for the satisfactory installation. Also included are any work, materials, tools, equipment, labor or incidentals necessary to complete this item.

II. PRESSURE REDUCING VALVE STATION NO. 4 VALVE ASSEMBLY: ITEM H3

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:

- Includes pressure reducing valves, piping with fittings, air release valves, gate valves, valve boxes, check valve, pressure gauges, saddle, curb stop and corporation stop valves, and appurtenances for complete installation.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

JJ. PRESSURE REDUCING VALVE STATION NO. 4 EXISTING PIPE CONNECTION: ITEMS H4

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:

- Includes connection to existing 6-inch PVC pipeline to include piping, valves, valve boxes, flush valve, assemblies, fittings, to and from PRV Vault.
- Thrust blocking, restrained joints if necessary, testing and disinfection; furnishing and installing the materials; marker posts (marked accordingly) and all materials.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

KK. PRESSURE REDUCING VALVE STATION NO. 4 DEMOLITION: ITEM H5

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:

- Abandon existing vault in place and remove all piping & appurtenances.
- Remove valve boxes and above ground piping.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

GG. PRESSURE REDUCING VALVE STATION NO. 5 SITE/CIVIL: ITEM I1

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. Price shall include all trench excavation to depths indicated, bedding/backfill; traffic control; shoring, dewatering, all surface restoration, and compaction.

HH. PRESSURE REDUCING VALVE STATION NO. 5 VAULT: ITEM I2

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. Price shall include the precast pressure reducing valve vault (9-ft x 6-ft x 6-ft) with hatch, ladder, and all other accessories, fasteners, and appurtenances required for the satisfactory installation. Also included are any work, materials, tools, equipment, labor or incidentals necessary to complete this item.

II. PRESSURE REDUCING VALVE STATION NO. 5 VALVE ASSEMBLY: ITEM I3

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:

- Includes pressure reducing valves, piping with fittings, air release valves, gate valves, valve boxes, check valve, pressure gauges, saddle, curb stop and corporation stop valves, and appurtenances for complete installation.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

JJ. PRESSURE REDUCING VALVE STATION NO. 5 EXISTING PIPE CONNECTION: ITEMS I4

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:

- Includes connection to existing 6-inch PVC pipeline to include piping, valves, valve boxes, flush valve, assemblies, fittings, to and from PRV Vault.
- Thrust blocking, restrained joints if necessary, testing and disinfection; furnishing and installing the materials; marker posts (marked accordingly) and all materials.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

KK. PRESSURE REDUCING VALVE STATION NO. 5 DEMOLITION: ITEM I5

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:

- Abandon existing vault in place and remove all piping & appurtenances.
- Remove valve boxes and above ground piping.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

GG. PRESSURE REDUCING VALVE STATION NO. 6 SITE/CIVIL: ITEM J1

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. Price shall include all trench excavation to depths indicated, bedding/backfill; traffic control; shoring, dewatering, all surface restoration, and compaction.

HH. PRESSURE REDUCING VALVE STATION NO. 6 VAULT: ITEM J2

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. Price shall include the precast pressure reducing valve vault (10-ft x 6-ft x 6-ft) with hatch, ladder, and all other accessories, fasteners, and appurtenances required for the satisfactory installation. Also included are any work, materials, tools, equipment, labor or incidentals necessary to complete this item.

II. PRESSURE REDUCING VALVE STATION NO. 6 VALVE ASSEMBLY: ITEM J3

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:

- Includes pressure reducing valves, piping with fittings, air release valves, gate valves, valve boxes, check valve, pressure gauges, saddle, curb stop and corporation stop valves, and appurtenances for complete installation.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

JJ. PRESSURE REDUCING VALVE STATION NO. 6 EXISTING PIPE CONNECTION: ITEMS J4

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:

- Includes connection to existing 6-inch PVC pipeline to include piping, valves, valve boxes, flush valve, assemblies, fittings, to and from PRV Vault.
- Thrust blocking, restrained joints if necessary, testing and disinfection; furnishing and installing the materials; marker posts (marked accordingly) and all materials.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

KK. PRESSURE REDUCING VALVE STATION NO. 6 DEMOLITION: ITEM J5

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:

- Abandon existing vault in place and remove all piping & appurtenances.
- Remove valve boxes, above ground piping, existing power pole, existing electrical boxes and chain link fence.
- Also included are any other work, materials, tools, equipment, labor or other incidentals necessary to complete this item.

NN. EXISTING CAMERON TANK TELEMETRY AND SCADA MODIFICATIONS INSTRUMENTATION: ITEM K1

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:

- Furnishing and installing all electrical and controls components associated with this tank including SCADA panels and antennas; and coordination with and connection to the local electrical utility.

END OF SECTION

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SECTION 01200

PROJECT MEETINGS

1.0 PRECONSTRUCTION CONFERENCE

The Construction Manager will schedule and conduct one 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.

2.0 CONSTRUCTION PERIOD MEETINGS

Construction period meetings will be conducted at weekly intervals or at some other frequency if approved by the Contractor and Construction Manager. These meetings shall be attended by the Construction Manager and the Contractor's Project Manager and any others that are invited by these people.

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 meetings will be conducted by the Construction Manager. Construction Manager 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 01300

SUBMITTALS

1.0 GENERAL

Submittals covered by these requirements include manufacturers' information, shop drawings, test procedures, test results, samples, requests for substitutions, and miscellaneous work-related submittals. Submittals shall also include, but not be limited to, all mechanical, electrical and electronic equipment and systems, materials, reinforcing steel, fabricated items, and piping and conduit details. The Contractor shall furnish all drawings, specifications, descriptive data, certificates, samples, tests, methods, schedules, and manufacturer's installation and other instructions as specifically required in the contract documents to demonstrate fully that the materials and equipment to be furnished and the methods of work comply with the provisions and intent of the contract documents.

2.0 CONTRACTOR'S RESPONSIBILITIES

A. GENERAL

The Contractor shall be responsible for the accuracy and completeness of the information contained in each submittal and shall assure that the material, equipment or method of work shall be as described in the submittal. The Contractor shall verify that all features of all products conform to the specified requirements. Submittal documents shall be clearly edited to indicate only those items, models, or series of equipment, which are being submitted for review. All extraneous materials shall be crossed out or otherwise obliterated. The Contractor shall ensure that there is no conflict with other submittals and notify the Construction Manager in each case where his submittal may affect the work of another contractor or the Owner. The Contractor shall coordinate submittals among his subcontractors and suppliers including those submittals complying with unit responsibility requirements specified in paragraph 11000-1.02 C and applicable technical sections.

The Contractor shall coordinate submittals with the work so that work will not be delayed. They shall coordinate and schedule different categories of submittals, so that one will not be delayed for lack of coordination with another. No extension of time will be allowed because of failure to properly schedule submittals. The Contractor shall not proceed with work related to a submittal until the submittal process is complete. This requires that submittals for review and comment shall be returned to the Contractor stamped "No Exceptions Taken" or "Make Corrections Noted."

The Contractor shall certify on each submittal document that they have reviewed the submittal, verified field conditions, and complied with the contract documents.

The Contractor may authorize in writing a material or equipment supplier to deal directly with the Construction Manager or with the Owner with regard to a submittal. These dealings shall be limited to contract interpretations to clarify and expedite the work.

3.0 CATEGORIES OF SUBMITTALS

A. GENERAL:

Submittals fall into two general categories; submittals for review and comment, and submittals which are primarily for information only. Submittals which are for information only are generally specified as PRODUCT DATA in Part 2 of applicable specification sections.

At the beginning of work, the Construction Manager will furnish the Contractor lists of those submittals specified in the project manual. Two separate lists will be provided: submittals for review and comment and product data (submittals) for information only.

B. SUBMITTALS FOR REVIEW AND COMMENT:

All submittals except where specified to be submitted as product data for information only shall be submitted by the Contractor to the Construction Manager for review and comment.

C. SUBMITTALS (PRODUCT DATA) FOR INFORMATION ONLY:

Where specified, the Contractor shall furnish submittals (product data) to the Construction Manager for Information only. Submittal requirements for operation and maintenance manuals, which are included in this category, are specified in Section 01730.

4.0 TRANSMITTAL PROCEDURE

A. GENERAL:

Unless otherwise specified, submittals regarding material and equipment shall be accompanied by Transmittal Form 01300-A specified in Section 01999. Submittals for operation and maintenance manuals, information and data shall be accompanied by Transmittal Form 01730-A specified in Section 01999. A separate form shall be used for each specific item, class of material, equipment, and items specified in separate, discrete sections, for which the submittal is required. Submittal documents common to more than one piece of equipment shall be identified with all the appropriate equipment numbers. Submittals for various items shall be made with a single form when the items taken together constitute a manufacturer's package or are so functionally related that expediency indicates checking or review of the group or package as a whole.

A unique number, sequentially assigned, shall be noted on the transmittal form accompanying each item submitted. Original submittal numbers shall have the following format: "XXX"; where "XXX" is the sequential number assigned by the Contractor. Resubmittals shall have the following format: "XXX-Y"; where "XXX" is the originally assigned submittal number and "Y" is a sequential letter assigned for resubmittals, i.e., A, B, or C being the 1st, 2nd, and 3rd resubmittals, respectively. Submittal 25B, for example, is the second resubmittal of submittal 25.

B. DEVIATION FROM CONTRACT:

If the Contractor proposes to provide material, equipment, or method of work which deviates from the project manual, they shall indicate so under "deviations" on the transmittal form accompanying the submittal copies.

C. SUBMITTAL COMPLETENESS:

Submittals which do not have all the information required to be submitted, including deviations, are not acceptable and will be returned without review.

5.0 REVIEW PROCEDURE

A. GENERAL:

Submittals are specified for those features and characteristics of materials, equipment, and methods of operation which can be selected based on the Contractor's judgment of their conformance to the specified requirements. Other features and characteristics are specified in a manner which enables the Contractor to determine acceptable options without submittals. The review procedure is based on the Contractor's guarantee that all features and characteristics not requiring submittals conform as specified. Review shall not extend to means, methods, techniques, sequences or procedures of construction, or to verifying quantities, dimensions, weights or gages, or fabrication processes (except where specifically indicated or required by the project manual) or to safety precautions or programs incident thereto. Review of a separate item, as such, will not indicate approval of the assembly in which the item functions.

When the contract documents require a submittal, the Contractor shall submit the specified information as follows:

1. Unless otherwise specified, one (1) electronic copy in Adobe ".pdf" format of all submitted information. Consolidate electronic format submittals with multiple pages into a single file. Include an electronic submittal transmittal form 01300-A as the first page in the electronic file.

2. 2. Unless otherwise specified, one (1) electronic copy in Adobe ".pdf" format of all submitted information shall be transmitted for submittals (Product Data) for information only.

3. Organize submittals in exactly the same order as the items are referenced, listed, and/or organized in the specification section.

4. For submittals that cover multiple devices used in different areas under the same specification section, the submittal for the individual devices must list the area where the device is used.

5. Where required, three (3) samples of submitted information shall be provided to the Construction Manager. Samples will not be returned. Provide samples from manufacturer's standard colors, materials, products, or

equipment lines. Clearly label samples to indicate any that represent non standard colors, materials, products, or equipment lines and that if selected, will require an increase in Contract Time or Contract Price.

6. If requested by Engineer, Contractor shall provide hardcopies of any submittals or shop drawings.

B. SUBMITTALS FOR REVIEW AND COMMENT:

Unless otherwise specified, within 10 working days after receipt of a submittal for review and comment, the Construction Manager shall review the submittal and return 1 electronic copy of the marked-up reproducible original noted in 1 above. Thirty (30) calendar days shall be allowed for review and response to shop drawings pertaining to the Pump Stations or PRV's. The reproducible original will be retained by the Construction Manager. The returned submittal shall indicate one of the following actions:

1. If the review indicates that the material, equipment or work method complies with the project manual, submittal copies will be marked "NO EXCEPTIONS TAKEN." In this event, the Contractor may begin to implement the work method or incorporate the material or equipment covered by the submittal.

2. If the review indicates limited corrections are required, copies will be marked "MAKE CORRECTIONS NOTED." The Contractor may begin implementing the work method or incorporating the material and equipment covered by the submittal in accordance with the noted corrections. Where submittal information will be incorporated in O&M data, a corrected copy shall be provided.

3. If the review reveals that the submittal is insufficient or contains incorrect data, copies will be marked "AMEND AND RESUBMIT." Except at his own risk, the Contractor shall not undertake work covered by this submittal until it has been revised, resubmitted and returned marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED."

4. If the review indicates that the material, equipment, or work method does not comply with the project manual, copies of the submittal will be marked "REJECTED - SEE REMARKS." Submittals with deviations which have not been identified clearly may be rejected. Except at his own risk, the Contractor shall 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."

C. SUBMITTALS (PRODUCT DATA) FOR INFORMATION ONLY:

Such information is not subject to submittal review procedures and shall be provided as part of the work under this contract and its acceptability determined under normal inspection procedures.

6.0 EFFECT OF REVIEW OF CONTRACTOR'S SUBMITTALS

Review of contract drawings, methods of work, or information regarding materials or equipment the Contractor proposes to provide, shall not relieve the Contractor of their responsibility for errors therein and shall not be regarded as an assumption of risks or liability by the Construction Manager or the Owner, or by any officer or employee thereof, and the Contractor shall have no claim under the contract on account of the failure, or partial failure, of the method of work, material, or equipment so reviewed. A mark of "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED" shall mean that the Owner has no objection to the Contractor, upon their 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 01310

CONSTRUCTION SCHEDULE

1.0 SCOPE

This section specifies reports and schedules for planning and monitoring the progress of the work.

2.0 DESCRIPTION

The Contractor shall provide a graphic construction schedule indicating the various subdivisions of the work and the dates of commencing and finishing each. The schedule shall show the time allowed for testing and for other procedures which must be completed prior to the work being put into operation. The schedule will take into account the time of completion and the specific dates given in Section 00520.

3.0 SUBMITTAL PROCEDURES

Within 20 days after the date of the Notice to Proceed, the Contractor shall submit in accordance with Section 01300, a construction schedule conforming to paragraph 01310-2.0. The submittal shall consist of a reproducible original and two copies.

Within 7 calendar days after receipt of the submittal, the Construction Manager shall review the submitted schedule and return one copy of the marked up original to the Contractor. If the Construction Manager finds that the submitted schedule does not comply with specified requirements, the corrective revisions will be noted on the submittal copy returned to the Contractor.

4.0 SCHEDULE REVISIONS

Revisions to the accepted construction schedule may be made only with the written approval of the Contractor and Owner. A change affecting the contract value of any activity, the completion time, and specific dates and sequencing may be made only in accordance with applicable provisions of Sections 00700 and 00800.

5.0 PROJECT STATUS UPDATE

Project status review and update shall be provided each month.

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SECTION 01400

QUALITY ASSURANCE, INSPECTION, AND TESTING

PART 1 GENERAL

1.01 SUMMARY

This section specifies administrative and procedural requirements for quality assurance and control services, special inspections, field testing and structural observations required for this project. This Section is supplementary to the applicable testing and inspection program in the Contract, and describes the responsibilities of all parties pertaining to testing and inspections.

This section covers requirements for quality assurance and inspection required in accordance with the latest version of the International Building Code and is in addition to and supplements the quality assurance requirements contained on the Contract Drawings.

The Contractor is responsible for providing quality workmanship and materials for the construction of this project in accordance with the Contract Documents.

The Contractor will engage and pay for the services of an Owner-approved Special Inspector and Laboratory Service. The Special Inspector shall be qualified to the satisfaction of the Building Official in accordance with Chapter 17 of the International Building Code. The Special Inspector shall be acceptable to the Owner in its sole discretion.

1.02 DEFINITIONS

A. Approved Agency: An agency approved by the Building Official to engage in furnishing testing or inspection services.

B. Certificate of Compliance: A certificate stating that materials and products meet specified standards or that work was performed in compliance with approved construction documents.

C. Registered Design Professional in Responsible Charge: An architect or engineer, licensed to practice in the State of Arizona, acting as the Owner's agent.

D. Resident Project Representative: The authorized representative of Engineer assigned to assist Engineer at the Site. As used herein, the term Resident Project Representative or "RPR" includes any assistants or field staff of Resident Project Representative. The term "Construction Manager," as used in this and other technical specifications, refers to the Resident Project Representative.

E. Special Inspection: Inspection of materials, installation, fabrication, erection or placement of components and connections requiring special expertise to ensure compliance with approved construction documents and referenced standards.

F. Special Inspection, Continuous: The full-time observation of work requiring special inspection by an approved Special Inspector who is present in the area where the work is being performed.

G. Special Inspection, Periodic: The part-time or intermittent observation of work requiring special inspection by an approved Special Inspector who is present in the area where the work is being performed and at the completion of the work.

H. Special Inspector: A qualified person who has demonstrated competence, to the satisfaction of the Building Official, to perform inspection of the construction or operation requiring special inspection.

I. Statement of Special Inspections: The quality assurance plan contained on the contract drawings establishing the systems and components subject to special inspection and testing, as well as the frequency of testing and extent and duration of the special inspection.

J. Structural Observation: The visual observation of the structural system by a registered design professional for general conformance to the approved construction documents at significant construction stages and at completion of the structural system.

1.03 REFERENCES

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.

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

Reference	Title
ASCE 7-10	Minimum Design Loads for Buildings and Other Structures
ASTM C1093	Practice for Accreditation of Testing Agencies for Unit Masonry
ASTM E329	Practice for Use in Evaluation of Inspection and Testing Agencies as Used in Construction
AWS D1.1	Structural Welding Code – Steel
AWS D1.2	Structural Welding Code – Aluminum
AWS D1.3	Structural Welding Code – Sheet Steel
AWS D1.4	Structural Welding Code – Reinforcing Steel
AWS D1.6	Structural Welding Code – Stainless Steel
AWS QC 1	Standard for AWS Certification of Welding Inspectors
IBC	International Building Code with local amendments
ICC-ES	International Code Council – Evaluation Service Reports and Legacy Reports

1.04 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

1. Fabricator Approval: Certification showing that fabricator is registered and approved to perform shop fabrication without special inspection.

2. Certificates of Compliance: Certificates of compliance shall be submitted stating that materials and products meet specified standards.

3. Contractor Statement: Prior to start of construction, Contractor shall submit statement of responsibility containing the following:

    a. Acknowledgement of awareness of special inspection requirements.
    b. Acknowledgement that control will be exercised to obtain conformance with documents approved by the Building Official.
    c. Procedures for exercising control within the Contractor's organization.
    d. Identification and qualifications of persons exercising control.

4. Testing Laboratory Qualifications: Prior to start of construction, submit latest inspection report of testing laboratory facilities indicating current accreditation by the accreditation authority.

1.05 STRUCTURAL OBSERVATION

A licensed engineer acting as the Owner's agent 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.

The following structural milestones shall be considered significant construction stages:

1. Structural fill.

2. Foundations prepared for concrete placement.

3. Preparation of masonry walls with reinforcing in place prior to placement of grout.

4. Completion of masonry bearing walls.

5. Steel roof framing, prior to cover-up with non-structural elements.

6. Completion of lateral force resisting elements including diaphragms, shear walls, and other elements.

7. Completion of structural system after all significant architectural, mechanical, plumbing, heating/ventilation equipment, electrical, and finish elements are installed.

1.06 INSPECTION AND TESTING

The Construction Manager/Resident Project Representative may throughout the duration of construction, inspect construction and require the Contractor to test materials to assure Contractor conformance with these specifications. Special inspections and associated testing, as shown on the drawings, will also be performed by approved Special Inspectors for compliance with the IBC. This testing will be in addition to that otherwise required of the Contractor in this and other specification sections.

1.07 COSTS

A. Paid by the Owner: None

B. Paid by the Contractor:

1. Testing to demonstrate and document conformance with the Contract Documents and applicable permits and codes, with the exception of Special Inspections and associated testing for compliance with IBC, Chapter 17 as identified in paragraph 1.07A above.

2. Retesting and re-inspections required due to defective work.

3. Testing performed for the convenience of the Contractor.

4. Mechanical and electrical component testing and certification.

5. Required inspections of fabricator(s) not registered and approved to perform shop fabrication without special inspection.

6. Special inspections and testing, as specified in this Section, will be paid by the Contractor. A cash allowance in the bid form has been included to cover these costs. Retests and re-inspections required due to defective work are also included.

1.08 CONTRACTOR'S RESPONSIBILITIES

Contractor shall cooperate with testing personnel. Contractor shall provide access to the work and supplier's operations.

Contractor shall deliver adequate samples of materials proposed to be used and which require testing to the Testing Laboratory or as otherwise directed by the Construction Manager/Resident Project Representative.

Contractor shall furnish casual labor and facilities, including but not limited to obtaining and handling samples, repairing of test areas to match original conditions, storage and curing of samples, etc.

Contractor shall provide all testing required to demonstrate compliance with the Contract Documents as well as all special inspections. Additional testing requirements are specified in the technical specification sections.

For all Contractor-required testing, the Contractor shall provide the services of an independent testing laboratory which complies with the requirements of ASTM E329.

1.09 SPECIAL INSPECTOR'S RESPONSIBILITIES

Special Inspector shall keep records of inspections.

Special Inspector shall provide inspection reports to the Construction Manager and Building Official.

Special Inspector shall provide a final report documenting special inspections and correction of any discrepancies noted in the inspections to the Construction Manager and Building Official.

Special Inspector shall attend pre-construction conferences and construction progress meetings if requested by the Construction Manager.

1.10 APPROVED AGENCY'S RESPONSIBILITIES

The Approved Agency shall employ personnel experienced and trained to perform the types of tests or inspections required for this project.

The Approved Agency personnel performing testing of welds shall be certified in accordance with AWS QC 1.

1.11 SPECIAL INSPECTION AND TESTING REPORTS

A. REPORT CONTENTS:

At a minimum, Special Inspection and Testing Reports shall include the following:

1. Project name and date of report.
2. Testing laboratory name, address, telephone number, name of laboratory field sampling personnel, and name of lab testing personnel, as applicable.
3. Date, time, and location of sampling, testing, and inspecting.
4. Ambient temperature and weather conditions at the site or shop and curing conditions of samples.
5. Product identification and referenced specification section number.
6. Type of sample, test, and inspection and industry standard for sampling and testing.
7. Results of sample, test, and inspection.
8. Evaluation of compliance with requirements in Contract Documents.

B. DISTRIBUTION OF REPORTS:

Test and Inspection reports shall be submitted to the Construction Manager and distributed by the Testing Laboratory as directed by the Construction Manager. Draft field test and inspection reports shall be submitted to the Construction Manager prior to the Special Inspector departing the project site. Final test and inspection reports shall be submitted not more than three days after completion of required tests and inspections. Inspection reports shall be submitted immediately to the Construction Manager if deficiencies or significant irregularities are noted. Provide two legible reproducible copies of all draft field reports and one copy of all final reports.

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

3.01 GENERAL:

The Contractor shall furnish access to the Work as required for special inspections, testing and structural observations.

The Contractor shall notify the Construction Manager in advance of required special inspections and structural observation no later than 3 days prior to the date of the inspection.

Contractor shall correct defective work at no additional cost to the Owner.

Structural observation will be performed by a registered professional engineer.

3.02 TESTING

Component and attachment testing shall be required of component manufacturers for mechanical and electrical components subject to special inspections for seismic resistance. The Contractor shall submit a certificate of compliance prepared by the component manufacturer.

Certificates of Compliance shall include the manufacturer's name and address; applicable Drawing and Detail number, products, units and assemblies, and system equipment identification.

END OF SECTION

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SECTION 01410

TESTING LABORATORY AND SPECIAL INSPECTION SERVICES

PART 1--GENERAL

1.01 DESCRIPTION

A. This Section specifies Quality Control testing and reporting performed by the Testing Laboratory and Special Inspector. The CONTRACTOR shall select a qualified Testing Laboratory and Special Inspector(s) and contract for the services specified herein. Such an arrangement does not relieve the Contractor from their responsibility to provide the completed project as specified, and to perform Quality Assurance according to the QCS as reviewed and accepted.

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 A880	Criteria for Use in Evaluation of Testing Laboratories and Organizations for Examination and Inspection of Steel, Stainless Steel, and Related Alloys
ASTM C802	Conducting an Inter-laboratory Test Program to Determine the Precision of Test Methods for Construction Materials
ASTM C1021	Laboratories Engaged in the Testing of Building Sealants
ASTM C1077	Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C1093	Accreditation of Testing Agencies for Unit Masonry
ASTM D3666	Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D3740	Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D4561	Quality Control Systems for Organizations Producing and Applying Bituminous Paving Materials
ASTM E4	Force Verification of Testing Machines
ASTM E329	Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
ASTM E543	Agencies Performing Nondestructive Testing
ASTM E994	Calibration and Testing Laboratory Accreditation Systems General Requirements for Operation and Recognition.
IBC	International Building Code with local amendments

1.03 LABORATORY FOR TESTING QUALIFICATIONS

A. Testing Laboratory shall satisfy the following qualifications:

1. Recommended Requirements for Independent Laboratory Qualification, published by American Council of Independent Laboratories.

2. Conform to the requirements of ASTM E329 in particular, and other reference standards as generally pertain to this project.

3. Authorized to operate in the State of Arizona, with personnel and equipment based sufficiently close to the project to allow short-notice site access for sampling and testing.

4. Acceptable to OWNER, Construction Manager, and local building authorities.

1.04 TESTING LABORATORY RESPONSIBILITIES

A. Testing Laboratory shall provide qualified personnel at the site and cooperate with Construction Manager and Contractor in performance of the following services:

1. Perform specified independent inspection, sampling, and testing of products in accordance with specified standards, to determine compliance with requirements of Contract Documents.

2. Provide sampling equipment and personnel, deliver samples to the testing laboratory, record field measurements, and cure samples as required by Contract Documents.

3. Perform Building Department required tests and inspections, including Special Inspection as specified in Section 01400.

4. Timely prepare and deliver reports summarizing results of tests and inspections.

5. Attend pre-construction conferences and, if requested, a limited number of progress meetings where Quality Control, testing, and inspection issues require discussion.

6. When directed by the Construction Manager or requested by the Contractor, provide special and additional tests and inspections to verify material compliance with requirements of Contract Documents.

   a. Contractor shall pay for special tests and inspections where work conforms to the Contract Document requirements.
   b. Contractor shall pay for additional tests and inspections where work fails to comply with Contract Document requirements (re-inspection) and for costs associated with cancelled or short-notice re-scheduling of requested sampling, testing, and inspection. Testing Laboratory work requested by Contractor to fulfill submittal requirements shall also be considered additional tests.

1.05 SPECIAL INSPECTOR'S RESPONSIBILITIES – SEE SECTION 01400.

1.06 CONTRACTOR RESPONSIBLITIES

A. Contractor shall deliver adequate samples of materials proposed to be used and which require testing by the Testing Laboratory. Contractor shall coordinate and cooperate with the Testing Laboratory personnel and provide access to the work and to manufacturer's facilities. Contractor shall provide incidental labor and facilities to provide access to work to be tested, to obtain and handle samples at

the site or at source of products to be tested, to facilitate tests and inspections, storage and curing of test samples.

B. Contractor shall notify Construction Manager 24 hours prior to expected time for operations requiring inspection, sampling and testing services unless otherwise noted.

1.07 TEST AND INSPECTION REPORTS

A. REPORT CONTENTS

At a minimum, Test and Inspection Reports shall include the following:

1. Project name and date of report.

2. Testing Laboratory name, address, telephone number, name of laboratory field sampling personnel, and name lab testing personnel, as applicable.

3. Date, time, and location of sampling, testing, and inspecting.

4. Ambient temperature and weather conditions at the site or shop and curing conditions of samples.

5. Product identification and referenced specification Section number.

6. Type of sample, test, and inspection and industry standard for sampling and testing.

7. Results of sample, test, and inspection.

8. Evaluation of compliance with requirements in Contract Documents.

9. Certified Inspection Reports shall specifically indicate the qualification of the inspector to render judgment and certify said inspection.

10. When requested by Construction Manager, interpretation of test results.

B. DISTRIBUTION OF TEST AND INSPECTION REPORTS

1. Test and Inspection reports shall be submitted to the Construction Manager for distribution as Product Data described in Section 01300. Test reports shall be submitted not more than two days after completion of required tests. Inspection reports shall be submitted immediately if deficiencies or significant irregularities are noted, and in no case less than two working days after said inspection. Provide two (6) copies of all reports.

1.08 SUBMITTALS

A. The following information shall be provided in accordance with Section 01300:

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 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, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Documentation of conformance with Testing Laboratory Qualifications as specified in paragraph 1.03 herein.

3. Form A described in paragraph 3.03 herein, by both Testing Laboratory and Contractor.

1.09 LIMITS ON TESTING LABORATORY AUTHORITY

A. Testing Laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents. Testing Laboratory may not approve or accept any portion of the work, nor assume any duties of Contractor. Testing Laboratory has no authority to stop the work.

PART 2--PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. GENERAL

1. Source quality control is defined in Section 01400. This Section provides general guidelines as to the sampling, tests, and inspections required of products and manufactures prior to delivery to the project site, and should be considered a minimum. Additional information and requirements are provided in each technical specification Section and those requirements

shall control over this Section when in conflict. Absence of a test, inspection or requirement listed herein from a subsequent specification Section does not relieve the Testing Laboratory or the Contractor from their respective responsibilities specified in this Section.

B. REFERENCE STANDARDS IN OTHER SECTIONS

1. Codes, standards, and other references called out below, but which are not listed in paragraph 1.02 are described in other specification Sections and not repeated herein.

C. FILL MATERIALS

1. IMPORTED FILL MATERIALS: Testing Laboratory may conduct additional testing on behalf of Contractor to prepare required submittals specified in Section 02200.

2. TYPE C AND D FILL MATERIAL: Testing Laboratory shall conduct required testing to verify on-site materials proposed for fill conforms to specification Section 02200. Contractor shall pay Testing Laboratory for such sampling and testing. Sampling and testing shall determine Liquid Limit, Plasticity Index, optimum moisture content and density relationship, and other data as required for proper use of this material.

D. PAVING MATERIALS – NOT USED

E. CONCRETE REINFORCING

1. Provide sampling and testing requested by Construction Manager or additional testing as requested by Contractor to verify materials proposed for use to specification Section 03200.

F. CAST-IN-PLACE CONCRETE

1. Provide sampling and testing requested by Construction Manager or additional testing as requested by Contractor to verify materials proposed for use conform to specification Section 03300. At Contractor's expense, Testing Laboratory may assist Contractor in formulating concrete mix designs, testing and reporting same, and providing the services of a Professional Engineer to review and seal the mix design.

G. PRECAST CONCRETE

1. PRECAST YARD INSPECTION: Source quality inspection is not required for PCI Certified facilities unless otherwise directed by the Building Official.

2. NON PCI CERTIFIED FACILITIES: Provide Special Inspection conforming to CBC Chapter 17 and PCI recommendations for all facets of operation including reinforcing, prestressing, concrete placing, finishing, and curing, form release and handling.

3. VAULTS, MANHOLES, AND NON-STRUCTURAL PRECAST CONCRETE ITEMS: Precast yard inspection is not required unless so directed by the Construction Manager due to quality concerns or lack of experience by the manufacturer. Such inspection and testing shall be paid for by the Contractor, and conform to this Section's requirements, as well as Section 03471.

H. MASONRY

1. CONFIRMATION OF MASONRY ASSEMBLAGE f'm: Prism testing, if elected rather than tabular method, shall be tested as Field Quality Control.

I. STRUCTURAL STEEL

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: 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: Testing Laboratory 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.

J. STEEL DECK

1. Provide sampling and testing requested by Construction Manager or additional testing as requested by Contractor to verify materials proposed for use conform to specification Section 05311.

K. ROUGH CARPENTRY

1. Provide sampling and testing requested by Construction Manager or additional testing as requested by Contractor to verify materials proposed for use conform to specification Sections 06100 and 06160.

L. MISCELLANEOUS METALWORK, GRATING, GUARDRAILING – NOT USED

M. PLASTIC LINING FOR STRUCTURES -NOT USED

N. COATING SYSTEMS

1. Provide sampling and testing requested by Construction Manager or additional testing as requested by Contractor to verify materials proposed for use conform to Contract Documents.

O. ENGINEERED METAL BUIDINGS – NOT USED

PART 3--EXECUTION

3.03 FIELD QUALITY CONTROL

A. GENERAL

1. Field quality control is defined in Section 01400. This Section provides general guidelines as to the sampling, tests, and inspections required of work in progress or completed in the field, and should be considered a minimum. Additional information and requirements are provided in each technical specification Section and those requirements shall control over this Section when in conflict. Absence of a test, inspection or requirement listed herein from a subsequent specification Section does not relieve the Testing Laboratory or the Contractor from their respective responsibilities specified in this Section.

B. REFERENCE STANDARDS IN OTHER SECTIONS

1. Codes, standards, and other references called out below, but which are not listed in paragraph 1.02 are described in other specification Sections and not repeated herein.

C. FILL

1. SUBGRADE PREPARATION AND COMPACTION: Verify depth of scarification, moisture content within optimal limits for compaction, and degree of compaction specified in Section 02200. 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 Construction Manager 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 Construction Manager 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 Construction Manager.

D. PAVING: NOT USED

E. CONCRETE REINFORCING

1. Provide Special Inspection for all structural reinforcing in concrete and masonry per IBC 1701.5 Item 4.

2. Provide Special Inspection for mechanical reinforcing connectors and splicing systems as required by that product's ICC Evaluation Report, or equivalent.

F. CAST-IN-PLACE CONCRETE

1. Sample the first daily truck load of ready mixed concrete and every 50 cubic yards thereafter, complying with ASTM C172.

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 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 C31.

4. Fabricate compressive strength specimens, complying with ASTM C39.

5. Make one set of 6 of compressive strength specimens for each day of structural concrete placing or each 100 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 318 for evaluation and acceptance of concrete.

G. PRECAST CONCRETE

1. SITE INSPECTION OF PRECAST CONCRETE STRUCTURAL ASSEMBLIES: Visually inspect precast plank, beam, hollowcore, or other precast systems after units are set in place, mechanically anchored, reinforcing and details completed but prior to placing concrete or grout which would prevent such inspection. Verify precast pieces conform to expected geometry, bearing conditions and camber.

2. COMPLETION OF PRECAST CONCRETE STRUCTURAL ASSEMBLIES: Inspect reinforcing, placement of concrete or grout fill as specified for those materials.

H. 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 ICC Evaluation Report, or equivalent.

2. SITE INSPECTION OF STRUCTURAL ANCHOR BOLTS: Visually inspect all structural anchor bolts for grade, diameter, embedment, geometry or type, 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).

I. GROUT

1. SITE INSPECTION OF MASONRY GROUTING: See Masonry section of this specification.

2. CEMENTITIOUS GROUT FOR STRUCTURAL BEARING: Visually inspect column baseplates, and grouted zone between structural struts/beams and their supporting wall elements. Determine complete fill beneath baseplate by tapping with hammer and noting hollow reports. Verify grout conforms to specification by observing empty bags, which Contractor shall leave visible adjacent to area until inspection complete.

3. EPOXY GROUT FOR EQUIPMENT BASES: Provide inspection conforming to specification Section 11002 and its reference standards, details on Drawings, and the requirements of the epoxy grout manufacturer.

J. MASONRY

1. CONFIRMATION OF MASONRY ASSEMBLAGE f'm: Demonstrate conformance with specified f'm using prism testing, unless tabular method accepted and completed. Prism preparation and testing shall conform to IBC Section 2105.3, and be at Contractor's expense as additional testing except for Testing Laboratory observation, inspection, and reporting defined therein.

2. INSPECTION OF REINFORCING, MASONRY LAYUP, AND GROUTING: Testing Laboratory shall provide all inspections and Special Inspections required by the IBC.

3. GROUT TESTING: Where grout is required to be sampled and tested, Testing Laboratory shall conduct such work conforming to IBC Section 2105.3.4, Item 4. Cylinders or mortar cubes may be used to confirm grout strength.

K. STRUCTURAL STEEL

1. SITE WELD INSPECTION FOR STRUCTURAL STEEL, STEEL JOISTS, AND STEEL FABRICATIONS: Visually inspect 100 percent of structural welds. Inspect 25 percent of fillet welds greater than 5/16 inch, 100 percent of butt welds, moment connection welds, and complete penetration groove welds by ultra-sonic or magnetic particle inspection.

2. 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.

3. FIELD INSPECTION OF HIGH-STRENGTH BOLTED CONNECTIONS: 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.

4. BEND TESTS: Perform bend test on 10 percent of welded shear connectors. Modify test method and frequency if alternate (non-welded) shear connectors utilized by Contractor.

L. STEEL ROOF DECK

1. STEEL ROOF DECK: Verify deck depth, gage (thickness), galvanizing, attachment to framing type, size, and frequency, sidelap fastening, and detail connections shown on the Drawings. Provide 100 percent visual inspection of all such decks, or other test method as dictated by supplier of alternate fastening systems, if any.

M. ROUGH CARPENTRY: NOT USED

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.

N. MISCELLANEOUS METALWORK, GRATING, GUARDRAILING: NOT USED

O. PLASTIC LINING FOR STRUCTURES: NOT USED

P. COATING SYSTEMS

1. FLEXIBLE, WATERTIGHT COATINGS ON CONCRETE: Provide field inspections specified for coating system per Section 09900.

2. OTHER COATING SYSTEMS: Provide inspection as requested by Construction Manager, and additional inspections as requested by Contractor.

Q. ENGINEERED METAL BUIDINGS: NOT USED

3.02 EVALUATION AND CORRECTION

A. EVALUATION

1. Satisfactory completion of work will be judged on results of laboratory, shop, and site tests and inspections.

B. CORRECTIONS

1. If results of tests and inspections indicate work is below requirements of Contract Documents, that portion of work is defective and shall be repaired or replaced by the Contractor at no additional expense to the OWNER by methods specified in each material or system's Section. Corrective action shall continue until such work meets the requirements of the Contract Documents.

3.03 SCHEDULE OF INSPECTIONS AND TESTS

A. Form A below shall be used to coordinate sampling and testing provided by Testing Laboratory, Special Inspector, Construction Manager, Contractor, and other parties, if any. Testing Laboratory shall fill out Form A with anticipated inspections, sampling, and testing, submit for review by Construction Manager and for information to Contractor, and revise as directed. After receipt of Testing Laboratory's/Special Inspector Form 01410-A submittal, Contractor shall submit Form 01410-A to identify sampling and testing requested for submittal preparation, and with an allowance for additional inspections. Such allowance

shall not be less than five percent (5%) of the anticipated Field Quality Control budget for the Testing Laboratory and Special Inspector, but shall not contractually commit Contractor to such expenditure, unless additional inspections requested and then only to their extent.

FORM 01410-A

ANTICIPATED SAMPLING, TESTING, AND INSPECTIONS BY TESTING LABORATORY AND CONTRACTOR

Prepared by: Testing Laboratory, Special Inspector, Contractor (check one).
Electronic version available upon request. Expand each cell as necessary to provide a complete scope description.

Specification Section	**Source Quality Control**	**Field Quality Control**
02200 Earthwork		
02743 Asphalt Concrete Pavement		
03200 Concrete Reinforcement		
03300 Cast-In-Place Concrete		
03600 Grout		
04200 Masonry		
05100 Structural Metals		
05311 Steel Roof Deck		
05501 Anchors		
05505 Miscellaneous Metalwork		
06100 Rough Carpentry		
06160 Sheathing		
09900 Finishes		

END OF SECTION

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SECTION 01500

CONTRACTOR'S UTILITIES

1.0 OFFICE

The Contractor shall maintain a suitable office at the site of the work.

2.0 POWER

The Contractor shall provide power for construction at the construction sites. They shall make arrangements with the electrical utility and with the Owner for power takeoff points, voltage and phasing requirements, transformers and metering and shall pay the costs and fees arising therefrom. The Contractor shall provide the special connections required for their work.

3.0 TELEPHONE

The Contractor shall provide telephone service at their construction site office.

4.0 SANITARY FACILITIES

The Contractor shall provide toilet and washup facilities for their work force at the site of work. The facilities shall comply with applicable laws, ordinances, and regulations pertaining to the public health and sanitation of dwellings and camps.

END OF SECTION

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SECTION 01560

ENVIRONMENTAL CONTROLS

1.0 SITE MAINTENANCE

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.

2.0 TEMPORARY DAMS

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.

Measures to protect and maintain water quality shall be in accordance with Section 01561 STORM WATER POLLUTION PREVENTION PLAN (SWPPP).

3.0 AIR POLLUTION CONTROL

The Contractor shall not discharge smoke, dust, and other contaminants into the atmosphere that violate the regulations of any legally constituted authority. They 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.

4.0 NOISE CONTROL

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 01561

STORM WATER POLLUTION PREVENTION PLAN (SWPPP)

PART 1--GENERAL

1.01 SCOPE

A. The CONTRACTOR shall provide all labor, equipment, materials, and services to acquire, prepare, implement and maintain best management practices (BMP) under a Construction General Permit (CGP) and Stormwater Pollution Prevention Plan (SWPPP) for construction activities that may adversely impact water quality.

1. The U. S. Environmental Protection Agency (EPA), Pacific Southwest, Region 9 is the permitting authority for all regulated stormwater discharges on Indian Lands. More information on stormwater permitting on Indian Lands within Arizona is available online at U.S. EPA and U.S. EPA Region 9 NPDES Stormwater Program at:

2. Pacific Southwest (Region 9) NPDES Wastewater & Stormwater Permits | US EPA Definitions shall be in accordance with EPA

3. For information about the storm water program in EPA's Pacific Southwest Region (AZ, CA, NV, Pacific Islands, and Tribal lands), contact: Eugene Bromley, bromley.eugene@epa.gov (415) 972-3510, Christopher Henninger, Henninger.christopher@azdeq.gov, (602)-771-4508 or Spencer York, York.spencer@azdeq.gov, (602)-771-4502.

1.02 SUBMITTALS

A. The CONTRACTOR shall submit record copies of the following documents to the CONSTRUCTION MANAGER:

1. Approved Notice of Intent (NOI)

2. Approved SWPPP and amendments

3. Notice of Termination (NOT) following completion of construction and final /permanent stabilization

4. Inspection and non-compliance reports that at a minimum include name of the inspector, time and date, reason for the inspection, and any findings on the conditions of the SWPPP controls and any location(s) of discharges of sediments or other pollutants from the site, BMP's that require maintenance, additional BMPs required, corrective actions to be taken, and evidence of or potential for pollutant discharge from the site.

1.03 CONTRACTOR'S RESPONSIBILITIES

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

1. The Storm Water Pollution Prevention Plan shall be developed in accordance with the permit requirements and EPA guidebook, "Developing Your Pollution Plan: A Guide for Construction Sites" (EPA publication number 833-R-06-004). The guidebook is a reference for information relating to the different methods of stormwater pollution prevention presented in this SWPPP.

2. The CONTRACTOR shall amend the SWPPP as necessary during completion of the Work if there are changes to the site that significantly affect the discharge of pollutants or if inspection or investigation determine the approved SWPPP is no longer effective at mitigating pollutants in stormwater discharges.

B. The CONTRACTOR shall provide a “qualified person” to perform inspections according to the inspection schedule provided in the approved SWPPP, before and/or during predicted rain events and “spot” inspections as requested by the CONSTRUCTION MANAGER to ensure Best Management Practices (BMPs) are in place and maintained.

1. A “qualified person” is a person knowledgeable in the principles and practice of erosion and sediment controls and pollution prevention, who possesses the skills to assess conditions at the construction site that could impact stormwater quality, and the skills to assess the effectiveness of any stormwater controls selected and installed to meet the requirements of the SWPPP and CGP.

C. The CONTRACTOR shall maintain a copy of the approved grading and drainage plan, NOI, up to date SWPPP and inspection reports available on site at all times for review.

D. Construction Wastes: The CONTRACTOR is responsible for proper disposal of all construction wastes in accordance with all applicable Federal, State, and local codes.

1. Unless otherwise required by code, 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.

E. Sanitary Wastes: Disposal of sanitary waste from the construction site shall meet all applicable Federal, State, and local codes.

1. The CONTRACTOR shall hire a licensed sanitary waste management firm for the disposal of the sanitary waste from the construction site, including from the CONTRACTOR's trailers.

F. 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.

1. 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.

G. Construction access 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.

PART 2--PRODUCTS

A. NOT USED

PART 3--EXECUTION

3.01 MAINTENANCE AND INSPECTION

A. Perform joint inspections with the CONSTRUCTION MANAGER per the approved SWPPP schedule and after any storm event unless otherwise specified.

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

1. Remove accumulated sediment and debris from silt fences before it loses thirty percent (30%) of its storage capacity. Remove accumulated sediment and debris before other BMP lose fifty percent (50%) of storage capacity.

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

3.02 SPILL PREVENTION

A. Only materials used for completion of Work performed as part of this construction project shall be stored on-site.

B. The handling and storage of all materials shall follow the Manufacturer's written instructions, the site conditions, project Specifications, or applicable governmental codes; whichever is most stringent. Materials shall be stored in a neat and orderly fashion in their original containers.

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

D. 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.

3.03 HAZARDOUS MATERIALS SPILL PREVENTION AND PRACTICES

A. The following precautions shall be followed for hazardous materials:

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

2. Products shall remain in their original containers with the original legible product label attached to the container. All products shall be used before disposal of the container.

3. Hazardous materials shall be stored separately from non-hazardous material on-site.

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 codes.

   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. If the stormwater is found to be contaminated, the CONTRACTOR shall follow the spill control measures for this hazardous material.

5. Hazardous materials shall be disposed of in accordance with proper disposal procedures and in accordance with all Federal, State, or local codes.

B. PRODUCT SPECIFIC PRACTICES

1. 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.

2. 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 dumping or via the storm drain system.

3. 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.

4. 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.

5. 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 CONSTRUCTION MANGER.

3.04 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 CONSTRUCTION MANGER, OWNER, and all applicable 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. After a spill is contained and cleaned up, a spill occurrence report shall be completed by the on-site inspector and the SWPPP shall be modified to prevent a reoccurrence of a spill.

END OF SECTION

SECTION 01580

PROJECT IDENTIFICATION SIGNS

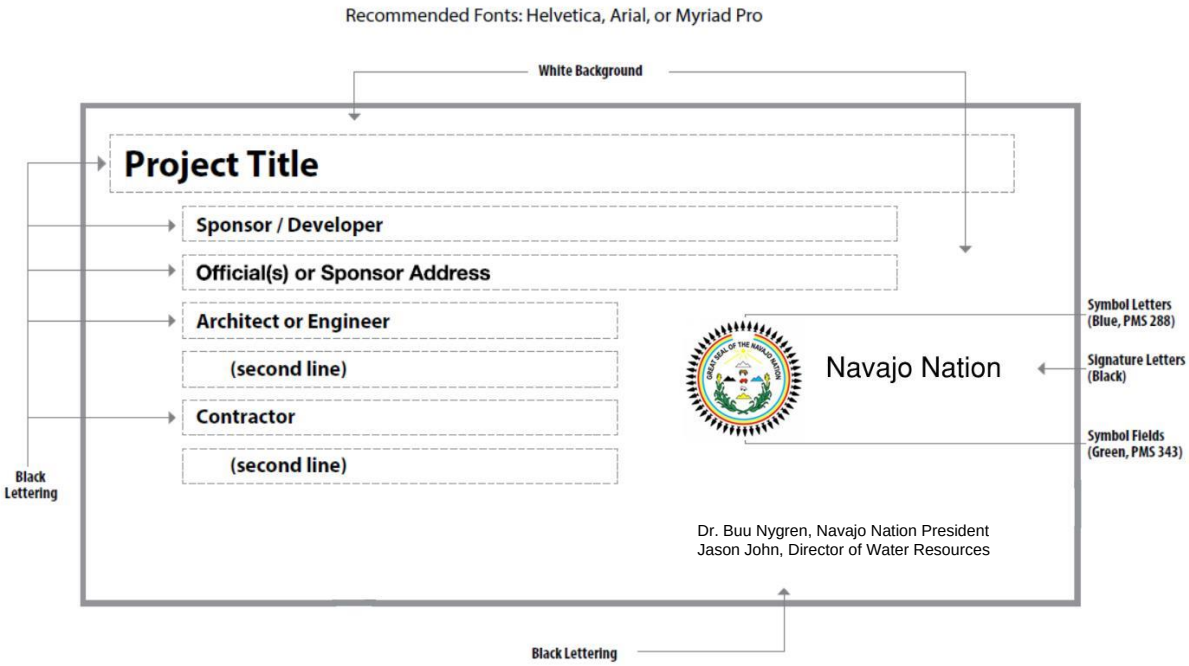
The Contractor shall provide one 4-foot by 8-foot multicolored signboard with a multi-colored "Navajo Nation" emblem. Signboard shall be provided with 1-1/4-inch by 4-inch edging, shall be constructed of exterior grade high density overlaid plywood, and shall be mounted and located in an acceptable manner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

Western Navajo Pipeline Project – Cameron and Bodaway-Gap Chapters Booster Pump Stations and Pressure Reducing Valve Station Project.

The Contractor shall erect the sign in accordance with the details shown on Figure 01580-1 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.

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 01580-1

END OF SECTION

SECTION 01605

SHIPMENT, PROTECTION AND STORAGE

1.0 GENERAL

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.

2.0 PIPE

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.

3.0 EQUIPMENT

A. PACKAGE AND MARKING:

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.

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.

B. IDENTIFICATION:

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.

C. SHIPPING:

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

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.

D. FACTORY APPLIED COATINGS:

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 09900. 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. Electrical equipment and materials shall be painted by manufacturer as specified in paragraph 09900-3.03 I.

E. STORAGE:

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.

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.

F. PROTECTION OF EQUIPMENT AFTER INSTALLATION:

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 01660

EQUIPMENT AND SYSTEM PERFORMANCE AND OPERATIONAL TESTING

PART 1--GENERAL

1.01 DESCRIPTION

This section contains requirements for the Contractor's performance in documenting testing work required under this contract. In addition, this section contains requirements the 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:

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 pump station operation and maintenance. The quality assurance program shall include:

1. A testing plan setting forth the sequence in which all testing work required under this project manual will be implemented.

2. A documentation program to record the results of all equipment and system tests.

3. An installed performance testing program for all mechanical, electrical, instrumentation, and HVAC equipment and systems installed under this contract.

4. A calibration program for all instruments, meters, monitors, gages, and thermometers installed under this contract.

5. A calibration program for all instruments, gages, meters, and thermometers used for determining the performance of equipment and systems installed under this contract.

6. A testing schedule conforming to the requirements specified in paragraph 01660-2.02 C.

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:

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.

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:

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.

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
AWWA M6	Water Meters – Selection, Installation Testing and Maintenance

1.03 SUBMITTALS

Submittal material, to be submitted in accordance with Section 01300, 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 01660-2.02 A, 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 01660-1.02 A requirements.

PART 2--PRODUCTS

2.01 GENERAL

The Contractor shall prepare test plans and documentation plans as specified in the following paragraphs. The Construction Manager/Resident Project Representative will not witness any test work for 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:

The Contractor shall develop a record 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.

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/Resident Project Representative'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:

1. Metallurgical tests
2. Factory performance tests
3. Accelerometer recordings made during shipment
4. Field calibration tests[1]
5. Field pressure tests[1]
6. Field performance tests[1]
7. Field operational tests[1]

Section 01999 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/Resident Project Representative as a condition precedent to the Contractor's receipt of progress payments more than 50 percent of the contract amount. Once the Construction Manager/Resident Project Representative

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

has reviewed and taken no exception to the forms proposed by the Contractor, the Contractor shall produce enough forms, at his expense, to provide documentation of all testing work to be conducted as a part of this contract.

B. TEST PLANS:

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:

1. 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.

2. Calibration of all analysis instruments and control sensors.

3. 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.

4. System tests designed to duplicate, as closely as possible, operating conditions described in the project manual.

Test plans shall contain a complete description of the procedures to be employed to achieve the desired test environment.

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/Resident Project Representative 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/Resident Project Representative. No test work shall begin until the Contractor has delivered the specified number of final test plans to the Construction Manager/Resident Project Representative.

C. TESTING SCHEDULE:

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 01310. 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/Resident Project Representative will not witness any testing work for acceptance until the Contractor has submitted a schedule to which the Construction Manager/Resident Project Representative 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

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

Once all equipment and systems have been tested individually, the Contractor shall fill all systems with the intended process fluids. After filling operations have been completed, the Contractor shall operate all systems for a continuous period of not less than 2 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/Resident Project Representative.

2.05 PRODUCT DATA

Product data, to be provided in accordance with Section 01300, shall be the original and three copies of all records produced during the testing program.

PART 3--EXECUTION

3.01 GENERAL

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/Resident Project Representative'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

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/Resident Project Representative.

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 01662.

3.03 PERFORMANCE TESTS

A. GENERAL:

Performance tests shall consist of the following:

1. Pressure and/or leakage tests.

2. Electrical testing as specified in Section 16030.

3. Wiring, individual component, loop, and loop commissioning testing as described in Section 17030.

4. Preoperational checkout for all mechanical and HVAC equipment. Preoperational check-out procedures shall be reviewed and approved by the respective equipment manufacturers.

5. Initial operation tests of all mechanical, electrical, HVAC, and instrumentation equipment and systems to demonstrate compliance with the performance requirements of this project manual.

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/Resident Project Representative after receipt of a written request, complete with justification of the need for the change in sequence.

B. PRESSURE AND LEAKAGE TESTS:

Pressure and leakage tests shall be conducted in accordance with applicable portions of Divisions 3 and 15. All acceptance tests shall be witnessed by the Construction Manager/Resident Project Representative. Evidence of successful completion of the pressure and leakage tests shall be the Construction Manager's/Resident Project Representative's signature on the test forms prepared by the Contractor.

C. FUNCTIONAL CHECKOUT:

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 Section 16030.

D. COMPONENT CALIBRATION AND LOOP TESTING:

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 Section 17030.

E. ELECTRICAL RESISTANCE:

Electrical resistance testing shall be in accordance with Section 16030.

F. PREOPERATIONAL TESTS:

Preoperational tests shall include the following:

1. Alignment of equipment using reverse dial indicator method.

2. Preoperation lubrication.

3. 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/Resident Project Representative 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 within 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/Resident Project Representative. 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.

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/Resident Project Representative and the Contractor regarding the test results or the methods or equipment used in the performance of such test, then the Construction Manager/Resident Project Representative may order the test to be repeated. If the repeat test, using such modified methods or equipment as the Construction Manager/Resident Project Representative 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 their expense.

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/Resident Project Representative, 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/Resident Project Representative, as a result of repeating such tests.

3. POSTTEST 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/Resident Project Representative. All machines or devices which exhibit unusual or

unacceptable operating characteristics shall be disassembled and inspected. Any defects found during the inspection shall be repaired or the specific part or entire equipment item shall be replaced to the complete satisfaction of the Construction Manager/Resident Project Representative at no cost to the Owner.

3.04 OPERATIONAL TESTS

The Contractor shall provide system operation testing. After completion of all performance testing and certification by the Construction Manager/Resident Project Representative that all equipment complies with the requirements of the specifications, the Contractor shall fill all process units and process systems, except those employing domestic water, oil, air, or chemicals, with well water. All domestic water, oil, air, and chemical systems shall be filled with the specified fluid.

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/Resident Project Representative. The operational testing period shall commence after this initial period of variable operation. The operational testing period shall be 5 days. 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.

As-built documents specified in Section 01720 of facilities involved shall be accepted and ready for turnover to the Owner at the time of operational testing.

END OF SECTION

SECTION 01662

COMMISSIONING

PART 1--GENERAL

1.01 DESCRIPTION

This section contains requirements for the Contractor's performance during the commissioning of the structures, equipment and systems constructed and installed during this contract. All commissioning work, as described in this section, shall be performed by the Contractor.

1.02 QUALITY ASSURANCE

A. CLEANUP:

Following completion of the operational testing period, the Contractor shall remove, clean, and replace all permanent and temporary filters and strainers in all pipeline systems; replace all HVAC filters; dewater and clean all sumps; and dewater all process units for final inspection as a condition precedent to commissioning.

B. COMMISSIONING TEAM:

The Contractor shall assemble a commissioning team under the direction of an individual duly authorized to commit the Contractor's personnel and resources to respond to requests for assistance on the part of the Construction Manager or, through the Construction Manager, the Owner. The commissioning team shall consist of representatives of the Contractor's mechanical, electrical, and instrumentation subcontractors, and others as appropriate. The commissioning team shall be available at the site of the work during normal working hours (8 hours a day, 5 days a week, Saturdays, Sundays, and legal holidays excepted) and shall be available within 2 hours' notice at all other times upon notice by telephone. The commissioning team shall at all times be equipped and ready to provide for emergency repairs, adjustments, and corrections to the equipment and systems installed and modified as a part of this contract.

1.03 SUBMITTALS

The following information shall be submitted to the Construction Manager in accordance with the provisions of Section 01300:

1. Detailed plans for commissioning each process unit and each system constructed or modified as a part of the work performed under this contract.
2. The Contractor's plan for providing a commissioning team conforming to the requirements of paragraph 01662-1.02 B during the commissioning period. The plan shall be complete with a daytime staffing plan and names,

qualifications, and telephone numbers of those assigned to off-hour standby duty.

PART 2--PRODUCTS

Working with representatives of the Owner and the Construction Manager, the Contractor shall develop and produce a detailed, written plan for the startup and initial operation, under actual operating conditions, of the equipment and systems installed and constructed under this contract. The document, after acceptance by the Construction Manager, shall serve as the guidance manual for the commissioning process.

PART 3--EXECUTION

After completion of the equipment and system performance and operational testing, where required, and agreement on the part of the Construction Manager that the systems did meet all test requirements, commissioning will begin. The commissioning period for each modified or new unit process system shall be 4 weeks. The Contractor shall remove all temporary piping, bulkheads, controls and other alterations to the permanent systems that may have been needed during the performance and operational testing and shall perform the tasks necessary to make the improvements constructed under this contract fully operational. The Construction Manager shall confirm in writing the date(s) that the system is ready for commissioning and on which actual commissioning activities commence. Activities conducted prior to such written confirmation shall not constitute commissioning.

The Owner's operation and maintenance personnel will be responsible for operation of the systems to be commissioned. The portion of the work to be commissioned shall be fully operational, performing all functions for which it was designed.

The Contractor shall be available at all times during commissioning periods to provide immediate assistance in case of failure of any portion of the system being constructed. At the end of the commissioning period and when all corrections required by the Construction Manager to assure a reliable and completely operational facility are complete, the Construction Manager shall issue a completion certificate. Each system shall have been issued a completion certificate as a condition precedent to the final acceptance of the work of this contract.

During the commissioning period, the Owner shall be responsible for all normal operational costs and the Contractor shall bear the costs of all necessary repairs or replacements, including labor and materials, required to keep the portion of the plant being commissioned, operational.

END OF SECTION

SECTION 01664

TRAINING

PART 1--GENERAL

1.01 DESCRIPTION

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

Where required by the detailed specifications, the Contractor shall provide on-the-job training of the Owner's 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

The following information shall be submitted to the Construction Manager in accordance with the provisions of Section 01300. 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

Where specified, the Contractor shall conduct training sessions for the Owner'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

Training sessions shall take place at the site of the work in Cameron at the Booster Pump Station No. 1 site.

2.03 LESSON PLANS

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.

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

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 Owner'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 Owner'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.

PART 3--EXECUTION

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 11000-B specified in Section 01999.

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.

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 01710

FINAL CLEANUP

1.0 GENERAL

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.

2.0 OWNER OCCUPANCY

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.

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.

3.0 POST-CONSTRUCTION REPAIRS

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.

4.0 SITE CLEANUP

For all roadway work, the Contractor shall conform the work to acceptable line and grade, as determined by the 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 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.

For pipelines, storm sewers, catch basins, manholes, and all building floor drains, prior to their activation or at the conclusion 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.

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

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

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

END OF SECTION

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SECTION 01720

RECORD DRAWINGS

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; including X, Y, and Z coordinates for all fittings and valves after installation and before burial; (2) additional documents such as schedules, lists, drawings, and electrical and instrumentation diagrams included in the specifications; and (3) Contractor layout and installation drawings.

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 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.

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:

Additions - Red
Deletions - Green
Comments - Blue
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 01730

OPERATING AND MAINTENANCE INFORMATION

1.0 SCOPE

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.

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

2.0 TYPES OF INFORMATION REQUIRED

A. GENERAL:

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:

Specific instructions, procedures, and illustrations shall be provided for the following phases of operations:

1. SAFETY PRECAUTIONS: List personnel hazards for equipment and list safety precautions for all operating conditions.

2. OPERATOR PRESTART: Provide requirements to set up and prepare each system for use.

3. START-UP, SHUTDOWN, AND POSTSHUTDOWN PROCEDURES: Provide a control sequence for each of these operations.

4. NORMAL OPERATIONS: Provide control diagrams with data to explain operation and control of systems and specific equipment.

5. 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.

6. OPERATOR SERVICE REQUIREMENTS: Provide instructions for services to be performed by the operator such as lubrication, adjustments, and inspection.

7. 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:

The following information shall be provided for preventive and scheduled maintenance to minimize corrective maintenance and repair:

1. LUBRICATION DATA: Provide lubrication data, other than instructions for lubrication in accordance with paragraph 2.0-B6.

   a. A table showing recommended lubricants for specific temperature ranges and applications;

   b. Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities; and

   c. A lubrication schedule showing service interval frequency.

2. 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:

Manufacturer's recommendations shall be provided on procedures and instructions for correcting problems and making repairs.

1. 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.

2. 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.

3. MAINTENANCE AND REPAIR PROCEDURES: Provide instructions and list tools required to restore product or equipment to proper condition or operating standards.

4. 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.

5. 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.

6. 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:

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.

1. 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 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.

2. 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.

3. PERSONNEL TRAINING REQUIREMENTS: Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly.

4. 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.

3.0 TRANSMITTAL PROCEDURE

Unless otherwise specified, O&M manuals, information, and data shall be transmitted in accordance with Section 01300 accompanied by Transmittal Form 01730-A and Equipment Record Forms 01730-B and/or 01730-C, as appropriate, all as specified in Section 01999. 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.

One (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 outside cover page 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 Table of Contents.

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.

4.0 PAYMENT

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.

5.0 FIELD CHANGES

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

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SECTION 01800

ENVIRONMENTAL CONDITIONS

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.

The Cameron Pump Station No. 1 site is at elevation **4286** feet above mean sea level. The site of work for the Pump Station No. 1 is located at a lat/long of 35°52'19.00"N and 111°24'52.55"W. The Cameron Pump Station No. 2 site is at elevation **5031** feet above mean sea level. The site work for Pump Station No. 2 is located at a lat/long of 36°12’58.26”N and 111°24’07.55”W. The Cameron Pump Station No. 3 site is at elevation of **5138** feet above mean sea level. The site of work for the Pump Station No. 3 is located at a lat/long of36°15’29.69”N and 111°25’19.51”W. The Bodaway-Gap/Cameron PRV No. 1 site is at elevation of **5172** feet above mean sea level. The site of work for PRV No. 1 is located at a lat/long of 36°16’41.66”N and 111°26’12.61”W. The Bodaway-Gap/Cameron PRV No. 2 site is at elevation of **5086** feet above mean sea level. The site of work for PRV No. 2 is located at a lat/long of 36°15’30.92”N and 111°25’08.71”W. The Bodaway-Gap/Cameron PRV No. 3 site is at elevation of **4879** feet above mean sea level. The site of work for PRV No. 3 is located at a lat/long of 36°12’16.58”N and 111°23’38.81”W. The Bodaway-Gap/Cameron PRV No. 4 site is at elevation of **4705** feet above mean sea level. The site of work for PRV No. 4 is located at a lat/long of 36°09’25.82”N and 111°23’43.60”W. The Bodaway-Gap/Cameron PRV No. 5 site is at elevation of **4436** feet above mean sea level. The site of work for PRV No. 5 is located at a lat/long of 36°04’33.03”N and 111°23’09.52”W. The Bodaway-Gap/Cameron PRV No. 6 site is at elevation of **4385** feet above mean sea level. The site of work for PRV No. 6 is located at a lat/long of 36°02’42.28”N and 111°23’33.47”W. 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**

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

END OF SECTION

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SECTION 01900

STRUCTURAL DESIGN AND ANCHORAGE REQUIREMENTS FOR NONSTRUCTURAL COMPONENTS AND NONBUILDING STRUCTURES

PART 1—GENERAL

1.01 SUMMARY

A. SCOPE

This section specifies the minimum structural requirements for the design, anchorage and bracing of architectural/mechanical/HVAC/electrical components, equipment, and systems, and nonbuilding structures. Design of supports, attachments and bracing for all parts or elements of the architectural, mechanical, HVAC and electrical systems shall be provided in accordance with this section. The requirements of this section shall apply to the design of the structural elements and features of equipment and to platforms/walkways that are provided with equipment or nonbuilding structures.

This section applies to nonstructural components that are permanently attached to structures, and nonbuilding structures as defined below in paragraph 1.01-B and ASCE 7-10. Note that equipment is defined as a non-structural component and tanks are defined as a nonbuilding structure.

Design shall be in accordance with the criteria listed within this section and shall conform to the provisions of the 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 the technical specification sections.

The following nonstructural components are exempt from the seismic design loading requirements of this section:

1. Mechanical and electrical components in Seismic Design Category C provided that the component importance factor, I_p, is equal to 1.0.

B. DEFINITIONS:

1. STRUCTURES: 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.

2. NONSTRUCTURAL COMPONENTS: The nonstructural 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 the effects of wind, snow, impact, temperature and seismic loads. Nonstructural components include, but are not limited to, ceilings, partitions, windows, equipment, piping, ductwork, furnishings, lights, etc.

3. NONBUILDING STRUCTURES: All 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. Nonbuilding structures include, but are not limited to, pipe racks, storage racks, stacks, tanks, vessels and structural towers that support tanks and vessels.

1.02 QUALITY ASSURANCE

A. QUALITY CONTROL BY OWNER:

Special Inspection of nonstructural components and nonbuilding 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 herein. Where sampling and testing required herein conforms to Special Inspection standards, such sampling and testing need not be duplicated.

B. REFERENCES:

Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly.

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

Reference	Title
AAMA	American Architectural Manufacturer's Association
ACI 318-14	Building Code Requirements for Structural Concrete

Reference	Title
AISC 341	Seismic Provisions for Structural Steel Buildings
ACI 360-10	Specification for Structural Steel Buildings
ASCE 7-10	Minimum Design Loads for Buildings and Other Structures
AWS D1.1	Structural Welding Code – Steel
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.6	Structural Welding Code – Stainless Steel
IBC	International Building Code with local amendments
NFPA-13	Standard for the Installation of Sprinkler Systems
OSHA	U.S. Dept. of Labor, Occupational Safety and Health Administration
ADOSH	Arizona Division of Occupational Safety and Health
SMACNA	Seismic Restraint Manual Guidelines for Mechanical Systems

1.03 SUBMITTALS

For structural elements of nonstructural components and nonbuilding structures required to be designed per this specification section, drawings and design calculations shall be stamped by an Arizona licensed professional engineer qualified to perform structural engineering.

Submit drawings and calculations no less than four weeks in advance of the installation of any component to be anchored to the structure or installation of any structural member to which the component will be attached.

A. The following submittals shall be provided in accordance with Section 01300:

1. List of all nonstructural components and nonbuilding structures requiring wind and seismic design and anchorage.

2. Shop drawings showing details of complete wind and seismic bracing and anchorage attachment assemblies including connection hardware, and embedment into concrete.

3. Shop drawings showing plans, elevations, sections and details of equipment support structures and nonbuilding structures, including anchor bolts, structural members, platforms, stairs, ladders, and related attachments.

4. Identify all interface points with supporting structures or foundations, as well as the size, location, and grip of all 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.

5. Calculations for all supports, bracing, and attachments shall clearly indicate the design criteria applied in the design calculations. Concrete embedment calculations shall be coordinated 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 the design calculations.

6. Product Data: Manufacturer's certificates of compliance with the seismic force requirements of this section.

1.04 DESIGN CODES

The following standard codes have application at this site for:

Buildings/Structures:	International Building Code 2015 and ASCE 7-10
Reinforced concrete:	ACI 318-14
Structural steel:	AISC 360-10 and AISC 341-10
Welding:	AWS Welding Codes, Latest Edition
Occupational health and safety requirements:	U.S. Dept. of Labor, Occupational Safety and Health Administration (OSHA)

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

1.05 DESIGN LOADS

All nonstructural components and nonbuilding structures shall be designed for the following loads. Wind and snow loads shall not be applied to nonstructural components and nonbuilding structures that are located inside buildings.

A. DEAD LOADS:

An additional allowance will also be added for piping and conduit when supported and hung from the underside of equipment and platforms.

B. UNIFORM LIVE LOADS:

Elevated grating floors:	100 psf
Columns:	No column live load reduction allowed
Stairs, storage areas, and landings:	100 psf
Equipment platforms, walkways/catwalks (other than exitways):	100 psf
Utility bridges:	75 psf per level minimum

C. SNOW LOADS:

Code:	IBC 2015 & ASCE 7-10
Ground Snow Load (p_g)	30 psf
Exposure Factor (Ce)	0.9
Importance Factor (I):	1.2
Minimum Roof Snow Load:	30 psf

D. WIND LOADS:

Code:	IBC 2015 & ASCE 7-10
Basic Wind Speed (3-second gust):	120 mph
Exposure:	C
Topographic Factor (K_{zt})	1.0

All exterior nonstructural components and nonbuilding structures, unless located in a pit or basin, shall be designed to withstand the design wind loads without consideration of shielding effects by other structures.

E. SEISMIC LOADS:

Code:	IBC 2015 & ASCE 7-10
0.2 Sec. Mapped Spectral Response, S_S:	0.365 g
1.0 Sec. Mapped Spectral Response, S_1:	0.104 g
Site Class:	C
0.2 Sec. Design Spectral Response, S_{DS}:	0.292 g

1.0 Sec. Design Spectral Response, S_{D1}:	0.118 g
Importance Factor (I):	1.5
Component Importance Factor (I_p):	1.0, except I_p=1.5 for fire protection sprinkler systems or components containing hazardous materials
Seismic Design Category	C

Seismic loads shall be calculated based on the governing building code. The structure dead load shall include equipment operating loads.

Individual members shall be checked for seismic and full member live load acting simultaneously, except that flooded equipment loads (infrequent occurrence) need not be combined with seismic loads. Equipment operating loads shall be combined with seismic loads.

F. IMPACT LOADS:

Impact loads shall be considered in the design of support systems.

The following impact load factors shall be used 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
Monorail Hoists:	
Vertical	25% of lifted load
Longitudinal	10% of lifted load
Hangers supporting floors and platforms:	33% of live and dead load

G. TEMPERATURE:

The effects of temperature shall be included in design where nonstructural components and nonbuilding structures are exposed to differential climatic conditions. See Section 1.07 for temperature extremes.

1.06 LOAD COMBINATIONS

All nonstructural components and nonbuilding structures shall be designed to withstand the 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, then the load shall be ignored when evaluating that member.

1.07 DESIGN CONSIDERATIONS

All nonstructural components and nonbuilding structures shall be designed for the following conditions:

A. CLIMATIC CONDITIONS:

Maximum design temperature:	100	degrees Fahrenheit
Minimum design temperature:	10	degrees Fahrenheit

B. FOUNDATIONS:

Foundations supporting nonstructural components and nonbuilding structures shall extend below the frost line or be supported on non-frost susceptible structural fill down to the frost line.

Frost line for foundations:	30 inches

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

1.08 COLUMN BASE FIXITY

Column bases shall be designed as pinned connections. No moments shall be assumed to be transferred to the foundations.

Where significant shear loads (greater than 5,000 lb. per anchor bolt) are transferred at column base plates, the equipment vendor shall provide a shear key.

1.09 DEFLECTIONS

Maximum beam deflections as a fraction of span for walkways and platforms shall be L/240 for total load and L/360 for live load. Maximum total load deflection for equipment supports shall be L/450.

PART 2—PRODUCTS

2.01 GENERAL

Materials shall be in conformance with information shown on the drawings and in other technical specification sections. See individual component and equipment specifications for additional requirements.

PART 3—EXECUTION

3.01 GENERAL

A. Attachments and braces shall be made in such a manner that the component force is transferred to the lateral force-resisting system of the structure. Attachment requirements and size and number of braces shall be based on the calculations submitted by the Contractor.

B. All 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 shall be responsible for any 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 the Owner.

C. Anchor bolts shall be provided and installed by the Contractor in accordance with Section 05501. Size of anchor bolts and embedment of anchor bolts shall be based on the calculations submitted by the Contractor.

D. Details of and calculations for all anchorages shall be submitted and accepted in accordance with paragraph 1.03 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. The Contractor shall be responsible for revisions to the anchorages and/or strengthening of the structural support so that there is no overstressed condition at no additional cost to the Owner.

END OF SECTION

SECTION 01999

REFERENCE FORMS

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

Form No.	Title
01300-A	Submittal Transmittal Form
01660-A	Equipment Test Report Form
01730-A	Operation and Maintenance Transmittal Form
01730-B	Equipment Record Form
01730-C	Equipment Record Form
09900-A	Coating System Inspection Checklist
11000-A	Manufacturer's Installation Certification Form
11000-B	Manufacturer's Instruction Certification Form
11000-C	Unit Responsibility Certification Form
11002-A	Rigid Equipment Mount Installation Inspection Checklist
11060-A	Motor Data Form
16000-A	Wire and Cable Resistance Test Data Form
16000-B	Installed Motor Test Data Form
16000-C	Dry Transformer Test Data Form
17000-A	Loop Wiring and Insulation Resistance Test Data Form
17000-G	Field Switch Calibration Test Data Form
17000-H	Transmitter Calibration Test Data Form
17000-I	Miscellaneous Instrument Calibration Test Data Form
17000-J	Individual Loop Test Data Form
17000-K	Loop Commissioning Test Data Form
17000-L	PLC Control Panel Test Data Form
17000-M	Radio Test Data Form

SUBMITTAL TRANSMITTAL

Submittal Description: _____ Submittal No:[1] _____

Spec Section: _____

	Routing	Sent	Received
OWNER: Navajo Tribal Utility Authority (NTUA)	Contractor/CM		
PROJECT: Western Navajo Pipeline Cameron Booster Pump Stations and Pressure Reducing Valve Stations	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 paragraph 01300-4.0 A, Transmittal Procedure.

01660-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.

CITY OF SAMPLE

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
PREOPERATIONAL CHECKLIST				
Mechanical				
Lubrication				
Alignment				
Anchor bolts				
Seal water system operational				
Equipment rotates freely				
Safety guards				
Valves operational				
Hopper purge systems operational				
Sedimentation tank/hopper clean				
O&M manual information complete				
Manufacturer's installation certificate complete				
Electrical (circuit ring-out and high-pot tests)				
Circuits:				
Power to MCC 5				
Control to HOA				

	Contractor		Construction Manager	
	Verified	Date	Verified	Date
Indicators at MCC:				
Red (running)				
Green (power)				
Amber (auto)				
Indicators at local control panel				
Wiring labels complete				
Nameplates:				
MCC				
Control station				
Control panel				
Equipment bumped for rotation				
Piping Systems				
Cleaned and flushed:				
Suction				
Discharge				
Pressure tests				
Temporary piping screens in place				
Instrumentation and Controls				
Flowmeter FE2502F calibration				
Calibration Report No.				
Flow recorder FR2502G calibrated against transmitter				
VFD speed indicator calibrated against independent reference				
Discharge overpressure shutdown switch calibration				
Simulate discharge overpressure Shutdown				
FUNCTIONAL TESTS				
Mechanical				
Motor operation temperature satisfactory				
Pump operating temperature satisfactory				
Unusual noise, etc?				
Pump operation: 75 gpm/50 psig				
Measurement:				
Flow:				
Pressure:		Test gage number:		
Alignment hot				
Dowelled in				
Remarks:				

	Contractor		Construction Manager	
	Verified	Date	Verified	Date
Electrical				
Local switch function:				
Runs in *HAND*				
No control power in *OFF*				
Timer control in *AUTO*				
Overpressure protection switch PS2502C functional in both *HAND* and *AUTO*				
Overpressure protection switch PS2502C set at 75 psig				
PLC 2500 set at 24-hour cycle, 25 min *ON*				
OPERATIONAL TEST				
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 _____

01730-A. OPERATION AND MAINTENANCE TRANSMITTAL FORM

Date: _____ Submittal No:[2] _____

To: _____ Contract No: Contract 3

_____ Spec. Section: _____

_____ Submittal Description: _____

_____ From: _____

Attention: _____ _____

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 paragraph 01300-4.0 A, Transmittal Procedure.

01730-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			
PART NO	QUAN	PART NAME	COST

ELECTRICAL NAMEPLATE DATA			
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			

01730-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

09900-A COATING SYSTEM INSPECTION CHECKLIST

09900-A Coating System Inspection Checklist			
Project Name	Western Navajo Pipeline Cameron Booster Pump Stations and Pressure Reducing Valve Stations		
Owner	Navajo Tribal Utility Authority (NTUA)	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.)	

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			

Step	Description		Name	Signature	Date
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			
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			

Step	Description		Name	Signature	Date
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			

11000-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: _____

_____

_____

_____

_____

_____ _____

Date Manufacturer

_____

Signature of Authorized Representative

_____ _____

Date Contractor

_____

Signature of Authorized Representative

11000-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:	

_____ _____

Date Manufacturer

_____

Signature of Authorized Representative

_____ _____

Date Signature of Owner's Representative

_____ _____

Date Signature of Contractor's Representative

(Project Title)

CERTIFICATE OF UNIT RESPONSIBILITY
for Specification Section _____

_____
(Section title)

In accordance with paragraph 11000-1.02 C 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 Sections___ ____, _____, and _____ .

We have reviewed the requirements for Sections 11000 (and 11050 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: _____

11002-A. RIGID EQUIPMENT MOUNT INSTALLATION CHECKLIST

(CLIENT, PROJECT NAME)

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: _____ Date___/___/___
Contractor Rep.

Name: _____ Name: _____
Construction Manager Millwright

Step 2: Completion of Cleaning and Concrete Substrate Preparation Prior to Grouting

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Name: _____
Construction Manager Grouting Contractor Rep.

Name: _____
Grout Manufacturer's Technical Rep.

Step 3: Equipment Leveling

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Name: _____
Construction Manager Millwright

Step 4: Installation of Protection of Adjacent Surfaces or Structures NOT TO BE GROUTED

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Name: _____
Construction Manager Grouting Contractor Rep.

Name: _____
Grout Manufacturer's Technical Rep.

Step 5: Preparation and Construction of Forms and Epoxy Grout Filling Standpipes

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Name: _____
Construction Manager Grouting Contractor Rep.

Name: _____
Grout Manufacturer's Technical Rep.

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: _____ Date___/___/___
Contractor Rep.

Name: _____ Date___/___/___
Grouting Contractor Rep.

Name: _____ Date___/___/___
Grout Manufacturer's Technical Rep.

Name: _____ Date___/___/___
Construction Manager

Step 7: Epoxy Grout Installation

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Name: _____
Construction Manager Grouting Contractor Rep.

Name: _____
Grout Manufacturer's Technical Rep.

Step 8: Completion of Full and Proper Cure of Epoxy Grout

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Date___/___/___
Grouting Contractor Rep.

Name: _____ Date___/___/___
Grout Manufacturer's Technical Rep.

Name: _____ Date___/___/___
Construction Manager

Step 9: Completion of Localized Repair of Grout Voids

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Date___/___/___
Grouting Contractor Rep.

Name: _____ Date___/___/___
Grout Manufacturer's Technical Rep.

Name: _____ Date___/___/___
Construction Manager

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: _____ Date___/___/___
Contractor Rep.

Name: _____ Date___/___/___
Grouting Contractor Rep.

Name: _____ Date___/___/___
Grout Manufacturer's Technical Rep.

Name: _____ Date___/___/___
Construction Manager

11060-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:	°C
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 _____
(Paragraph 11060-2.04 G)

B. Nameplate or nominal efficiency _____

Data Not Necessarily Marked on Nameplate

Type of Enclosure:			Enclosure Material:		
Temp Rise:	°C (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:

_____

16000-A. WIRE AND CABLE RESISTANCE TEST DATA FORM

Wire or Cable No.:_____ Temperature, ^{o}F: _____

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

.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

16000-B. INSTALLED MOTOR TEST 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

16000-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 _____

17000-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

17000-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

17000-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

17000-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

17000-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 17000-A)

b. Not used.

c. Instruments calibrated:
(Attach test forms 17000-G 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

17000-K. LOOP COMMISSIONING TEST DATA FORM

Loop No.: _____

a. Loop tested:
(Attach test form 17000-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, demonstrate automatic start/stop and control operation.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000-L. PLC CONTROL PANEL TEST DATA FORM

Location: _____

A. PHYSICAL TEST:

List any discrepancies with respect to the panel specifications:

1. Dimensions, component layout and wiring specifications.

2. Panel and component hardware.

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

4. 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

17000-M. RADIO TEST DATA 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: _____
   a. Data Bits: _____
   a. Parity: _____
7. Quality of Workmanship – Antenna/Cable assmebly: _____

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

Navajo Nation
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

CAMERON PUMP STATIONS AND PRESSURE RELIEF VALVES

DIVISION 2

SITE CONSTRUCTION

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SECTION 02100

SITE PREPARATION

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies site preparation which consists of clearing, grubbing, demolition and salvage.

Removal and disposal of electrical Work is included in Division 16. Coordinate with the subcontractor and Owner for all materials required to be turned over to Owner.

B. EXISTING CONDITIONS:

The CONTRACTOR shall determine the actual condition of the site as it affects this portion of work.

C. PROTECTION:

Site preparation shall not damage existing utilities to remain in service, structures, landscaping or vegetation adjacent to the site. The CONTRACTOR shall repair or replace any damaged property.

Demolition activities shall not damage utilities to remain in service, structures, landscaping or vegetation adjacent to the site. The Contractor shall repair or replace any property damaged by demolition activities.

D. DEFINITIONS

1. REMOVAL: Facilities to be removed shall be completely removed from the site as shown and specified in the Contract Documents. Disposal shall conform to applicable codes and procedures when hazardous or contaminated materials are removed and disposed of.

2. ABANDON: Facilities to be abandoned shall remain in place and be abandoned in accordance with procedures as shown and specified in the Contract Documents.

3. SALVAGE: Equipment and appurtenances to be salvaged shall be removed without damage and delivered to Owner as shown and specified in the Contract Documents.

PART 2--PRODUCTS

No products are included in this section.

PART 3--EXECUTION

3.01 CLEARING AND GRUBBING

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.

Material that is removed and is not to be incorporated in the work shall be properly disposed of off the site in accordance with local, state and federal regulations.

3.02 DEMOLITION AND REMOVAL

A. STRUCTURES:

The existing six pressure reducing valve assembly and valve vault shall remain in service during construction of the replacement pressure reducing valve assembly and valve vault. After construction, testing and start-up activities are complete, and before Final Completion, the Contractor shall demolish the existing assembly and vault.

Demolition and removal of the assembly and vault consists of cutting and capping existing inlet and outlet pipes downstream and upstream of existing gate valves respectively, closing existing gate valves, removal of the top of the existing structure, as well as removal of air valve assembly valves, fittings, and piping. Material that is removed shall be properly disposed of off-site in accordance with local, state and federal regulations.

The existing valve vault shall be removed, to a point three feet below existing or proposed grade, whichever is lower. Contractor shall dispose of the existing manhole frame/cover and crack the vault base to permit drainage prior to backfill. Vaults and excavations shall be cleared of waste, debris and loose soil, and backfilled with clean, compacted Type C fill per Section 02200. Backfill shall match existing finished grades.

Excavations shall be cleared of waste, debris and loose soil, and backfilled with clean, compacted Type C fill per Section 02200. Backfill shall match existing finished grades.

The Contractor shall protect all existing utilities and related structure along the interconnection pipeline alignment and in the area of Work. Contractor shall coordinate with utilities to determine utility locations and required removal or protection procedures.

B. PAVEMENT:

When portions of asphalt pavements and concrete pads are to be removed and later construction is to be connected, edges shall be saw cut, on a neat line at right angles to the curb face.

C. SALVAGE:

The Owner has the right to salvage any items scheduled for removal. The CONTRACTOR shall notify the CONSTRUCTION MANAGER 15 days prior to any salvage or demolition work to determine the disposition of items to be removed. The CONSTRUCTION MANAGER will mark items to be salvaged. Such items shall be properly disconnected, removed from their foundations, cleaned, and stored at a location on site as directed by the CONSTRUCTION MANAGER.

3.03 UTILITY INTERFERENCE

Where existing utilities interfere with the prosecution of the work, the CONTRACTOR shall protect or relocate them in accordance with Division 0.

END OF SECTION

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SECTION 02200

EARTHWORK

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies earthwork which consists of excavation, filling, grading, and disposal of excess material.

B. 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.

4. EMBEDMENT ZONE: Embedment zone shall be defined as the area from the trench bottom to a level at least 12-inches over the top of the pipe including bedding, haunching and initial backfill.

1.02 QUALITY ASSURANCE

A. REFERENCES:

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.

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 C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
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
ASTM D 4253	Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

B. TESTS:

The CONTRACTOR will take samples and perform moisture content, gradation, compaction, and density tests during placement of backfill materials to check compliance with these specifications. The CONTRACTOR shall remove surface material at locations designated by the CONSTRUCTION MANAGER and provide such assistance as necessary for sampling and testing. The CONSTRUCTION MANAGER may direct the CONTRACTOR to construct inspection trenches in compacted or consolidated backfill to determine that the CONTRACTOR has complied with these specifications.

Tests will be made by the CONTRACTOR in accordance with the following:

Test	Standard Procedure
Moisture content	ASTM D6938
Gradation	ASTM C136
Density in-place	ASTM D1556 or D6938
Moisture-density relationships	ASTM D1557

The CONTRACTOR shall provide safe access to the trench or excavation for the inspection and compaction testing. This shall include providing all safety equipment and temporary shoring to enable inspection of the trench foundation and compaction testing at multiple levels in the trench.

1.03 SUBMITTALS

Samples of fill materials to be used shall be submitted 2 weeks in advance of use. Samples shall consist of 0.5 cubic feet of each type of material.

PART 2--MATERIALS

2.01 FILL MATERIALS

A. TYPE A:

Type A material (3/4-inch Minus) shall be a clean 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
3/8 inch	70-100
No. 4	40-99
No. 10	35-95
No. 20	20-80
No. 40	0-55
No. 100	0-2

B. TYPE B:

Type B material (3-inch Minus) 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 conform to the following gradation:

U.S. standard sieve size	Percent by weight passing
3 inch	100
3/4 inch	70-100
No. 4	40-100
No. 200	15-50

The coefficient of uniformity shall be 3 or greater.

The plasticity index of the material, as determined in accordance with ASTM D4318, shall not exceed 10.

The material may be an imported quarry waste, clean natural sand or gravel, select trench excavation or a mixture thereof.

C. TYPE C:

Type C material shall be unclassified silty sand material which is free from peat, wood, roots, bark, debris, garbage, rubbish or other extraneous material. The maximum size of stone shall not exceed 3 inches. The material shall have a maximum of 65% passing #4 sieve and maximum of 20% passing #200 sieve. If the native material excavated from the site meets these requirements, it may be segregated from non-conforming material and classified as Type C.

D. TYPE D:

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
3/4 inch	85-100
No. 4	45-95
No. 200	0-8

The granular base shall have a plasticity index of no greater than 3 when tested in accordance with ASTM D4318.

The coarse aggregate shall have a percent of wear, when subjected to the Los Angeles abrasion test (ASTM C131) of no greater than 50.

E. TYPE E:

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

U.S. standard sieve size	Percent by weight passing
1/2 inch	15-55
1/4 inch	0-5

Type E material shall be composed of hard, durable, sound pieces having a specific gravity of not less than 2.65

F. TYPE F:

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

Type F material shall be composed of hard, durable, sound pieces having a specific gravity of not less than 2.65.

G. TYPE G:

Type G material shall be Class l crushed stone (manufactured angular, crushed stone, crushed rock, or crushed slag), commonly known as chips and shall conform to the following gradation:

U.S. standard sieve size	Percent by weight passing
3/4 inch	100
No. 4	30-50
No. 200	0-5

The material shall have a minimum sand equivalent value of 75.

H. TYPE H:

Type H material shall be 6-inch crushed/angular 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

Specific gravity shall be between 2.5 and 2.82.

I. TYPE I:

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

Specific gravity shall be between 2.5 and 2.82.

J. TYPE J:

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. TYPE K

Native material, segregated from non-conforming material, may be used for bedding and backfill outside roadway and public right of ways or easements. The material shall be granular, free from peat, wood, roots, bark, clay lumps, debris, garbage, rubbish or other material as defined by the Construction Manager. All materials used as final backfill shall pass a 3-inch sieve. Materials used for select backfill or bedding shall meet the following gradation requirements:

U.S. standard sieve size	Percent by weight passing
3/4 inch	100
No. 4	40-90
No. 200	30 or less

The plasticity index of the material, as determined in accordance with ASTM D4318, shall not exceed 10. Native soils including high plasticity clay soils, sandy clay and clayey sand soils shall not be used as bedding or backfill.

The Contractor shall furnish sieve analyses per ASTM C 136, plasticity indexes PI - per ASTM D 4318 and baseline maximum density tests, Modified Proctor per ASTM D 1557, for conditioned native material. Acceptance by the Construction Manager of the tests shall be required prior to using these materials. All costs for testing shall be paid for by the Contractor. Native materials shall be tested once per 400 feet of trench or as directed by the Construction Manager. In all cases, soil samples for testing shall be taken in the presence of the Construction Manager.

The Contractor will be solely responsible to demonstrate compliance and where native materials do not meet the requirements, shall provide imported bedding and backfill at no additional cost to the Owner.

PART 3--EXECUTION

3.01 GENERAL

A. CONTROL OF WATER:

The CONTRACTOR shall keep excavations reasonably free from water during construction. The static water level shall be drawn down a minimum of 1 foot below the bottom of excavations to maintain the undisturbed state of natural soils and allow the placement of any fill to the specified density. Disposal of water shall not damage property or create a public nuisance.

The CONTRACTOR shall have on hand pumping equipment and machinery in good working condition for emergencies and shall have workmen available for its operation.

Dewatering systems shall operate continuously until backfill has been completed to 1 foot above the normal static groundwater level.

Groundwater shall be controlled to prevent softening of the bottom of excavations, or formation of "quick" conditions. Dewatering systems shall not remove natural soils. The CONTRACTOR shall control surface runoff to prevent entry or collection of water in excavations.

Release of groundwater to its static level shall be controlled to prevent disturbance of the natural foundation soils or compacted fill and to prevent flotation or movement of structures or pipelines.

The CONTRACTOR shall incorporate the use of temporary detention ponds, rock checks or rock socks to allow settlement or filtering of silt carried by the water before entering storm drains or natural waterways. Straw bales are not acceptable for this purpose.

If a National Pollutant Discharge Elimination System (NPDES) permit is required for disposal of water from construction dewatering activities, it shall be obtained by the CONTRACTOR prior to any dewatering activities.

B. OVEREXCAVATION:

The CONTRACTOR shall take care to avoid excavation below the depths indicated. However, where the undisturbed condition of natural soils is inadequate for support of the planned construction, the CONSTRUCTION MANAGER may direct the CONTRACTOR to overexcavate and install additional bedding material.

The quantity of overexcavation and placement of additional bedding material will be paid for on a unit price basis per cubic yard of overexcavation and additional material installed. The unit price shall include all costs associated with the overexcavation and installation of the additional material including but not limited to: bedding material, geotextile material, installation, and all testing.

C. SURPLUS MATERIAL:

Unless otherwise specified, surplus excavated material shall be disposed of off site in accordance with applicable ordinances and environmental requirements.

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.

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.

D. BORROW MATERIAL:

If the quantity of acceptable material from excavation is not sufficient to construct the embankments or trench backfill required by the work, the quantity of material needed to complete the embankments or trench backfill shall consist of imported borrow conforming to specified requirements.

E. HAULING:

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.

F. HAUL ROADS:

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 must stay within the designated limit of disturbance as shown in the drawings. Haul roads shall be removed after completion of construction.

G. FINISH GRADING:

Finished surfaces shall be smooth, compacted and free from irregularities. The degree of finish shall be that normally obtainable with a blade-grader.

Finished grade shall be as specified 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.

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.

If the soil is to be cultivated or straw is to be incorporated into the surface, 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 cultivation or placement of straw.

H. CONTROL OF EROSION:

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.

I. STABILIZATION:

Instead of or in addition to overexcavation and additional material as described in 02200-3.01B, the CONSTRUCTION MANAGER may direct the CONTRACTOR to stabilize the subgrade by pressing large riprap into the soft unstable subgrade to support the compaction of bedding, initial backfill and subsequent backfill. The quantity and placement of stabilization material will be paid for on a unit price basis per cubic yard of stabilization material installed. The unit price shall include all costs associated with the installation of the stabilization material including but not limited to: stabilization material, installation, and all testing.

3.02 CLASSIFICATION OF FILL

Fill material shall be placed in horizontal layers and compacted with power-operated tampers, rollers, idlers, or vibratory equipment. Material type, maximum layer 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 compaction, percent	General application
A1	A	6	95	Subsequent, near-surface pipeline backfill under paved roadways, roadway shoulders, roadway embankments and public Right-of-Ways or easements; pipeline bedding; initial utility pipeline backfill per trench detail in project drawings
NOT REQD	A	48	95	NOT REQUIRED
B1	B	8	95	Structural fill; subsequent pipeline backfill; compaction as specified
B2	B	8	90	Site fill; compaction as specified
C1	C	8	90-95	Subsequent pipeline backfill; compaction as specified
C2	C	8	90	Site fill for embankments and dikes
D1	D	8	95	Concrete slab support fill only for PRV Vault and in areas where structural fill is not specified

Fill class	Material type	Maximum uncompressed layer depth, inches	Minimum compaction, percent	General application
E1[a,b]	E	8	95 [b]	Bedding and initial pipeline backfill for RCP only, backfill for overexcavated zone; Requires layer of non-woven filter fabric between Type E and any other material containing fines (including native)
NOT REQD	F	12	95	NOT REQUIRED.
NOT REQD	G	8	95	NOT REQUIRED
H1[c]	H	-	-	Floor drain discharge area, Embankment slope face, channel slope face, stream bed installation above pipeline
H2[d]	H	-	-	Trench or Excavation bottom soil stabilization.
I1	I	-	-	Embankment slope face, channel slope face
J1[e]	J	8	90	Excess fill
K1	K	6	90	Subsequent, near-surface pipeline backfill nonpaved areas outside roadway and public Right-of-Ways or easements; per Typical Trench Detail; compaction as specified
K2	K	6	95	Pipeline bedding; initial utility pipeline backfill; per trench detail in project drawings; compaction as specified

[a]Compaction of layers shall be accomplished in two passes of equipment with complete coverage across the width of the fill. Dry density compaction shown is per ASTM D1557. Use 70% of ASTM D4253 maximum relative density, as applicable, based on the soil used for fill.
[b]NOT USED.
[c]NOT USED.
[d]Riprap to be pressed into unstable trench bottom soil until trench bottom will support placement and compaction requirements for backfill.
[e]Asphalt and concrete slabs from demolition may be placed at the bottom of the fill side by side to form a continuous pad. Clearing and grubbing is not required unless shrubs are taller than 3 feet. Mucking of the subgrade and keying or benching of adjoining embankments is not required.

3.03 EARTHWORK FOR STRUCTURES

A. STRUCTURE EXCAVATION:

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.

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 overexcavation 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.

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.

Upon completion of foundation excavations, the CONTRACTOR shall coordinate the inspection of the bottom of the excavation prior to the placement of structural fill or auger cast piles.

B. FOUNDATION TREATMENT:

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.

When footings are to be supported on piles, excavations shall be completed to the bottom of the footings before any piles are drilled or driven therein. When swell or subsidence results from driving piles, the CONTRACTOR shall excavate, or backfill the footing area to the grade of the bottom of the footing with suitable material as specified. If material under footings is such that it would mix into the concrete during footing placement or would not support the weight of the fluid concrete, the CONTRACTOR shall replace the material with suitable material, install soffit forms or otherwise provide a suitable platform on which to cast the footing as directed by the CONSTRUCTION MANAGER. This shall be paid for as extra work.

Where clay soils are encountered at the bottom of cut surfaces, the clay surface shall be scarified and mixed to a minimum depth of 12 inches and watered as necessary to bring the upper foot of soil to between 1 and 3 percent above the optimum moisture content and compacted to between 95 and 98 percent of maximum dry density.

Whenever solid or loose rock, rocky soil with rocks larger than 3/4 inches in their largest dimension, or otherwise unsuitable soils which are incapable of properly supporting the pipe are encountered in the trench bottom, all unsuitable material shall be overexcavated to a minimum depth of 6 inches (or 24 inches for soft or unstable areas) below the pipe and replaced with suitable bedding material.

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 00700-14.02.

C. STRUCTURE BACKFILL:

Unless otherwise specified, structure backfill shall be Class B1.

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.

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 the specified compressive design strength or until the concrete has been in place for 28 days, whichever occurs first.

Backfill material shall be placed in uniform layers and shall be brought up uniformly on all sides of the structure. When compaction is done by ponding and jetting, thickness of uncompacted layers shall not exceed 4 feet. Moisture content at the time of compaction of structural backfill shall be within 2 percent of optimum moisture content.

Compaction of structure backfill by ponding and jetting will not be allowed.

3.04 EARTHWORK FOR PIPELINES AND CONDUITS

A. GENERAL:

Earthwork for pipelines and conduits is specified in paragraph 02200-3.02, Table A; in the standard details; and in the following paragraphs.

B. PIPELINE EXCAVATION:

Unless otherwise specified, shown on the drawings, or approved by the CONSTRUCTION MANAGER, pipelines shall have a minimum 42-inch depth of cover and maximum 72-inch depth of cover. The top 12 inches of soil shall be removed and stored in such a manner that it will not become mixed with unsatisfactory soils. Excavate the trench to line and grade with allowance for pipe thickness, sheeting and shoring, pipe bedding and over-excavation.

The CONTRACTOR shall be responsible to deflect joints and/or provide shop-fabricated fittings as required to achieve the vertical and horizontal alignment. The provided alignment shall not include isolated high or low points requiring an air release valve or flush valve that is not shown on the drawings but required for the proper operation and

maintenance of the pressure pipeline as determined by the CONSTRUCTION MANAGER. Where the CONSTRUCTION MANAGER determines the Contractor's alignment has created a high or low point, the Contractor shall provide air release or flush valves in accordance with the Standard Details at no additional cost to the OWNER.

The allowable joint deflection shall not exceed 50% of the manufacturer's written maximum recommendation unless otherwise specified. When gasketed pipe is laid on a curve, the pipe shall be jointed in a straight alignment and then deflected to the curved alignment. CONTRACTOR shall provide a wider trench as required for this purpose at no additional cost to the OWNER. Longitudinal bending of the pipe shall not be allowed.

In the event obstructions are encountered which require exceptions to the allowable depth of cover, the CONSTRUCTION MANAGER shall have the authority to change the plans and order the necessary deviation from the line and grade.

Remove hard spots that would prevent a uniform thickness of bedding or result in concentrated loads on the pipe. If the trench is excavated below the required grade, refill any part of the trench excavated below the grade with specified bedding materials or in accordance with over-excavation requirements where unsuitable material is encountered.

Prior to placement of bedding, the exposed subgrade at the base of the trench excavation shall be examined to detect soft, loose, or unstable areas. Loose materials in the trench bottoms resulting from excavation disturbance should be removed until firm material is encountered. If soft or unstable areas are encountered, these areas should be overexcavated to a minimum depth of 24 inches below the pipe or to firm material and replaced with suitable bedding material.

Where clay soils are encountered at the bottom of cut surfaces, the clay surface shall be scarified and mixed to a minimum depth of 12 inches and watered as necessary to bring the upper foot of soil to between 1 and 3 percent above the optimum moisture content and compacted to between 95 and 98 percent of maximum dry density.

C. PIPELINE EMBEDDMENT ZONE:

Bedding and backfill material in the embedment zone shall be as specified and as shown on the project trench detail.

1. BEDDING: The CONTRACTOR shall not proceed with bedding placement in excavated areas until the subgrade has been inspected by the CONSTRUCTION MANAGER.

   All pipe shall have a minimum thickness of 6 inches of bedding material below the barrel of the pipe to provide uniform and adequate longitudinal support under the pipe as specified. Bedding material shall be placed in the bottom of the trench, leveled and compacted.

Bell holes shall be excavated to provide a minimum clearance of 2-inches below the coupling or bell at each pipe joint and to permit proper inspection of the joint. Imported Type A or conditioned Type K bedding material shall be placed at bell holes and beneath the pipe as required to provide uniform and adequate longitudinal support.

2. HAUNCHING: After pipe has been properly bedded and laid to alignment and grade, additional bedding material shall be placed in layers the full width of the trench and compacted. CONTRACTOR shall place and compact haunching, defined as the area between the top of bedding to the springline of the pipe, simultaneously on both sides of the pipe, keeping the level of material the same on each side.

   Haunching shall be carefully placed in 6" lifts and hand compacted around the pipe to ensure that the pipe barrel is completely supported with no voids or uncompacted areas and adequate side support to the pipe is provided without either vertical or lateral displacement of the pipe from proper alignment.

3. INITIAL BACKFILL: After placement of haunching material, CONTRACTOR shall place, and compact initial backfill from the springline to at least 12-inches above the top of the pipe.

   Initial backfill shall be placed and compacted in lifts not to exceed 6-inches in loose measure. Placement and compaction shall be performed in such a manner as to avoid damage or disturbance of the haunching material or pipe.

   Moisture content of trench backfill at the time of compaction shall be within 2 percent of optimum moisture content.

4. FINAL OR SUBSEQUENT BACKFILL:

   Backfill material, placement and compaction above the pipe zone shall be as specified. Backfill above the pipe zone shall not commence until pipe zone backfill has been inspected and accepted by the CONSTRUCTION MANAGER.

   a. IMPROVED AREAS: Unless otherwise specified, select granular backfill (Class A) shall be used under all paved and unpaved roadways and paved and unpaved roadway shoulders, roadway embankments, and in all public right-of-ways and easements. The trench shall be backfilled to an elevation which will permit the placement of the specified surface and paving as specified. Parking lot surface and paving shall be as specified in Section 02500. Roadway surface and paving shall be restored, including compaction,

to the condition existing prior to construction including restoration of yard areas.

b. UNIMPROVED AREAS: Class C1or Class K backfill shall be used for all trenches in pastureland, cultivated land, undeveloped land, and for other unimproved areas where specified. Class C1 backfill shall not be used in any public right-of- way or under roadways. Excavated trench material that meets the requirements of Type C material may be used. The CONTRACTOR shall maximize the use of fine-grained materials (e.g., sand, silty sand, sandy silt) as Class C1 backfill.

The trench above the pipe zone shall be backfilled to within 12 inches of original ground surface. Moisture content of trench backfill at the time of compaction shall be within 2 percent of optimum moisture content.

After the trench has been backfilled, the stored topsoil shall be replaced at a uniform depth in its original area compacted to its original condition. The CONTRACTOR shall leave the backfilled trench neatly mounded not more than 6 inches above existing grade for the full width of the backfill area.

The CONTRACTOR will be required to perform the work so that trenches will remain open for the minimum time required to accomplish the work. Do not begin trench excavation until appropriate compaction equipment is at the excavation site. During non-working hours, open trenches shall be completely covered or fenced to prevent access.

3.05 EARTHWORK FOR EMBANKMENTS

A. FOUNDATION PREPARATION:

The surface of the foundation shall not contain standing water and shall be free of loose material, foreign objects and rocks greater than 6 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:

Rocks, broken concrete, or other solid materials, which are larger than 4 inches in greatest dimension, shall not be placed in embankment areas where piles are to be placed or driven.

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.

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.

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.

The temporary differential elevation between any two adjoining zones of the embankment due to construction operations shall not exceed 24 inches.

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:

Where specified, a key shall be excavated along the length of the toe of fill slopes. The exposed soils along the key and under fill areas shall be disced and/or scarified to a depth of at least 12 inches, moisture conditioned to within 3 percent of optimum moisture content, and compacted to at least 90 percent of maximum dry density.

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.

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.

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.

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.

3.06 SUBGRADE FOR PAVEMENT

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.

3.07 SITE FILL

Unless otherwise specified, site fill shall be Class C2 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.

END OF SECTION

SECTION 02270

EROSION CONTROL (VEGETATIVE)

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 the 4H:1V.

1.02 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01300 - Submittals.

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

Navajo Nation
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

CAMERON PUMP STATIONS AND PRESSURE RELIEF VALVES

DIVISION 3

CONCRETE

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SECTION 03100

CONCRETE FORMWORK

PART 1 -- GENERAL

1.01 DESCRIPTION

This section specifies formwork requirements for concrete construction.

1.02 QUALITY ASSURANCE

A. REFERENCES:

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.

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
ACI 117	Standard Specifications for Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete
ACI 318	Building Code Requirements for Structural Concrete
ACI 347R	Guide to Formwork for Concrete
National Institute of Standards - PS1	Construction and Industrial Plywood

B. DESIGN:

Formwork design requirements shall conform to the following:

1. Formwork shall be designed by a Professional Engineer currently registered in the State of Arizona having a minimum of 3 years' experience in this type of design work.

2. Design and engineering of formwork as well as its construction, is the sole responsibility of the CONTRACTOR.

C. DESIGN CRITERIA:

Design of formwork shall conform to the following criteria:

1. Formwork shall be designed for loads, lateral pressures and allowable stresses outlined in ACI 347R and for design considerations, wind loads, allowable stresses and other applicable requirements of the controlling local building code. Where conflicts occur between the above two standards, the more stringent requirements shall govern.

2. Formwork shall be designed to limit maximum deflection of form facing materials reflected in concrete surfaces exposed to view to 1/240 of span between structural members.

1.03 SUBMITTALS

Submittals shall be provided in accordance with Section 01300 and shall include the following information:

1. Manufacturer's product data, installation instructions and acknowledgement that products submitted meet requirements of standards referenced for

   a. Form materials

   b. Form release compound.

   c. Form ties.

2. Formwork designer qualifications.

3. Submit letter of certification stamped by the registered Engineer referenced in paragraph 1.02B.1 that formwork has been designed in accordance with the specifications.

PART 2--PRODUCTS

2.01 FORMS

A. WOOD FORMS:

Wood forms shall be new and unused exterior grade plywood panels manufactured in accordance with APA (American Plywood Association) and bearing the trademark of that group. Forms for all concrete surfaces exposed to view shall be APA High Density Overlay (HDO) Plyform Class I Exterior 48" X 96" X 3/4" minimum thickness. Forms for other concrete surfaces shall be APA Douglas Fir B-B Plyform Class I Exterior 48” X 96” X 3/4-inch minimum thickness.

When approved by the CONSTRUCTION MANAGER, plywood may be reused.

B. METAL FORMS:

Metal forms excluding aluminum may be used. Forms shall be free of rust and straight without dents to provide members of uniform thickness.

2.02 FORM TIES

Form ties shall be commercially fabricated for use in form construction and shall be constructed so that ends or end fasteners can be removed without causing spalling at surfaces of the concrete. Diameter on ends shall be 3/4 inch minimum to 1 inch maximum. Embedded portion of ties shall be not less than 1 1/2 inch from face of concrete after ends have been removed. Ties with integral waterstops shall be provided in all water-retaining structures and in below grade structures exposed to a ground water level above the base slab.

2.03 FORM RELEASE COMPOUND

Coat all forming surfaces in contact with concrete using an effective, non-staining, non-residual, water based, bond-breaking form coating unless otherwise noted. Form release agents used in potable water containment structures shall be suitable for use in contact with potable water and shall be non-toxic and free of taste and odor. Form release agent shall not adversely affect concrete surfaces and shall not impair subsequent treatments of concrete surfaces.

PART 3--EXECUTION

3.01 PREPARATION

Preparation shall conform to the following:

1. Surfaces of forms shall be covered with an approved form release compound prior to form installation. Application shall be in accordance with manufacturer's recommendations.

2. Excess form coating material shall not be permitted to stand in puddles in forms nor in contact with hardened concrete against which fresh concrete is to be placed.

3. Surfaces of forms, reinforcing steel and other embedded materials shall be cleaned of any accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed.

3.02 CONSTRUCTION

Formwork construction shall conform to the following:

1. Forms shall be used for all cast-in-place concrete including sides of footings.

2. Forms shall be constructed and placed so that the resulting concrete will be of the shape, lines, dimensions, and appearance indicated on the Drawings. Forms shall be braced or tied together to maintain their position and shape under a load of freshly-placed concrete.

3. Forms shall be sufficiently tight to prevent leakage.

4. Temporary openings shall be provided at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed, and to limit height of free fall of concrete to prevent aggregate segregation.

5. Temporary openings, also called form "windows", shall be used to limit height of free fall of concrete and to limit the lateral movement of concrete during placement.

6. A 3/4-inch chamfer strip shall be placed in exposed to view corners of the forms to produce a 3/4-inch wide beveled edge.

7. At construction joints, contact surface of form sheathing for flush surfaces exposed to view over hardened concrete in previous placement shall be overlapped by at least 1 inch. Forms against hardened concrete shall be

held to prevent offsets or loss of mortar at construction joint and to maintain a true surface. Where possible, juncture of built-in-place wood or metal forms shall be located at architectural lines, control joints or at construction joints.

.8. Where circular walls are formed and forms made up of straight sections are proposed for use, straight lengths not exceeding 2 feet wide shall be provided for curved surfaces with a radius of 25 feet to 100 feet. Straight form lengths not exceeding 3 feet wide may be used for curved surfaces with a radius of 100 feet and larger. Formwork shall be braced and tied to maintain correct position and shape of members.

9. Wood forms for wall openings shall be constructed to facilitate loosening, if necessary, to counteract swelling. Formwork shall be anchored to shores or other supporting surfaces of members so that movement of any part of formwork system is prevented during concrete placement.

10. Runways for moving equipment shall be provided with struts or legs, supported directly on formwork or structural members without resting on reinforcing steel.

11. A positive means of adjustment (wedges or jacks) of shores and struts to take up all settlement during concrete placing operation shall be provided. Forms shall be securely braced against lateral deflection. Wedges used for final adjustment of forms shall be fastened prior to concrete placement in position after final check.

12. Sealer: Penetrating, clear, polyurethane wood form sealer formulated to reduce absorption of bleed water and prevent migration of set-retarding chemicals from wood.

13. Form Joint Sealant: Elastomeric sealant complying with ASTM C 920, Type M or S, Grade NS, that adheres to form joint substrates.

14. Coat contact surfaces of wood rustications and chamfer strips with sealer before placing reinforcement, anchoring devices, and embedded items.

15.

16. Do not fill rock pockets or honey combing in the exposed -to-public-view surfaces without approval of the ENGINEER and the Architect.

3.03 TOLERANCES

Formwork tolerances shall be in accordance with ACI 117 and the following. If a discrepancy is found between the requirements below and ACI 117, the more stringent requirement shall control:

1. Products shall be installed in accordance with manufacturer's written instructions.

2. Surfaces of columns, piers, walls, and risers shall vary from plumb a maximum of 1/2 inch for entire height and 1/4 inch in 10 feet of height. Exposed corner columns, control-joint grooves, and other exposed to view lines shall vary from plumb a maximum of 1/2 inch for entire length and 1/4 inch in 20 feet of length.

3. Maximum variation from level or from grade shall be 3/4 inch for entire length, 3/8 inch for any bay or 20 foot length, and 1/4 inch in 10 feet of length for slab soffits, ceilings, and beam soffits, measured before removal of supporting shores and shall be 1/2 inch for entire length and 1/4 inch in 20 feet of length for exposed lintels, sills, parapets, horizontal grooves, and other exposed-to-view lines.

4. Maximum variation of linear structure lines from established position in plan and related position of columns, walls, and partitions shall be 3/4 inch for entire length and 3/8 inch for any bay or 20 foot length.

5. Maximum variation in size and location of sleeves, floor openings, and wall openings and variation in horizontal plan location of beam, column and wall centerlines shall be ± 1/2 inch

6. Maximum variation in cross sectional dimensions of columns and beams and in thickness of slabs and walls shall be ± 3/8 inch and in concrete plan dimensions for footings and foundations shall be - 1/2 inch + 2 inches.

7. Maximum misplacement or eccentricity of footings and foundations shall be 2 percent of footing width in direction of misplacement, but not more than 2 inches.

8. Specified thickness of footings and foundations may be decreased by up to 5 percent with no maximum increase except that which may interfere with other construction.

9. Maximum step variance in the flight of stairs for Rise is ± 1/8 inch and for Tread is ± 1/4 inch and in consecutive steps for Rise is ± 1/16 inch and for Tread is ± 1/8 inch.

10. Sufficient control points and benchmarks to be used for reference purposes to check tolerances shall be established and maintained in an undisturbed condition until final completion and acceptance of the work.

11. Regardless of tolerances listed, no portion of a structure shall be allowed to extend beyond the legal boundary of work site.

12. To maintain specified tolerances, formwork shall be cambered to compensate for anticipated deflections in formwork prior to hardening of concrete.

14. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-in-place surfaces.

    a. Seal form joints and penetrations at form ties with form joint sealant to prevent cement paste leakage.

3.04 REMOVAL OF FORMS

Removal of forms shall conform to the following:

1. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.

2. When required for concrete curing in hot weather, required for repair of surface defects or when finishing is required at an early age, forms shall be removed as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support.

3. Top forms on sloping surfaces of concrete shall be removed as soon as concrete has attained sufficient stiffness to prevent sagging. Any needed repairs or treatment required on such sloping surfaces shall be performed at once, followed by curing specified in Section 03300.

4. Wood forms for wall openings shall be loosened as soon as this can be accomplished without damage to concrete.

5. Formwork for columns, walls, sides of beams, and other parts not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.

6. 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.

7. When shores and other vertical supports are so arranged that non-load-carrying form facing material may be removed without loosening or disturbing shores and supports, facing material may be removed when concrete has sufficiently hardened to resist damage from removal.

END OF SECTION

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SECTION 03200

CONCRETE REINFORCEMENT

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies reinforcing steel for use in reinforced concrete and masonry.

1.02 QUALITY ASSURANCE

A. REFERENCES:

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.

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Reference	Title
ACI 117	Standard Specifications for Tolerances for Concrete Construction and Materials
ACI 315	Details and Detailing of Concrete Reinforcement
ACI 318	Building Code Requirements For Structural Concrete and Commentary
ACI SP-66	ACI Detailing Manual
ASTM A615	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A706	Low-Alloy Steel Deformed Bars for Concrete Reinforcement

Reference	Title
ASTM A1064	Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
AWS D1.4	Structural Welding Code--Reinforcing Steel
CRSI-PRB	Recommended Practice for Placing Reinforcing Bars
CRSI-MSP 1	Manual of Standard Practice
FEDSPEC QQ-W-461H	Wire, Steel, Carbon (Round, Bare, and Coated)

B. SHIPPING, HANDLING AND STORAGE:

Reinforcing steel shall be shipped 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.

C. FABRICATION:

Reinforcing steel bars shall be fabricated in accordance with ACI 315 and the following tolerances:

1. Sheared lengths shall be within +/- 1 inch.

2. Overall dimensions of stirrups, ties, and spirals shall be within +/- ½ inch.

3. All other bends shall be within +0 inch, -½ inch

4. Minimum diameter of bends of reinforcing steel bars shall be as indicated in ACI 318..

1.03 SUBMITTALS

Submittals shall be provided in accordance with Section 01300 and shall include the following:

1. Mill certificates of mill analysis, tensile, and bend tests for all reinforcing.

2. Qualifications of welding operators, welding processes and procedures if used

3.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.

PART 2--PRODUCTS

2.01 BAR REINFORCEMENT

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.

2.02 WIRE FABRIC

Wire fabric shall be welded steel mesh conforming to ASTM A1064.

2.03 WIRE AND PLAIN BARS

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

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 TIE WIRE

The wire shall be minimum 16 gage annealed steel conforming to FEDSPEC QQ-W-461H.

2.06 BAR SUPPORTS

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-1 and placed in accordance with CRSI PRB.

1. Manufactured concrete block supports with embedded tie wires (wire dobies) shall be provided 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.

2. Stainless steel or plastic protected plain steel supports shall be provided for other work.

PART 3--EXECUTION

3.01 TOLERANCE

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 +/- ¼ inch of specified clearance and minimum spacing between bars shall be a maximum of ¼ inch less than specified.

2. Reinforcing steel top bars in slabs and beams shall be placed +/- $^{3}/_{8}$ inch of specified depth in members 8 inches deep or less and +/- ½ 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 ½ 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

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

Reinforcing steel splicing shall conform to the following:

1. Class B splice lengths in accordance with ACI 318, Chapter 12, shall be used for all reinforcing steel bars unless shown otherwise on the drawings.

2. 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.

3. Splices of reinforcement steel bars not specifically indicated or specified shall be subject to the approval of the ENGINEER. Mechanical proprietary splice connections may be used when approved by the ENGINEER or as indicated on the drawings.

4. Welding of reinforcing steel bars is not allowed unless approved by the ENGINEER.

3.04 CLEANING

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

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. Reinforcement shall be extended to within 2 inches of formed edges and 3 inches of the concrete perimeter when concrete is placed against earth.

3. Reinforcing steel bars shall not be bent after embedding in hardened concrete unless approved by the ENGINEER.

4. Tack welding or bending reinforcing steel bars by means of heat is prohibited.

5. 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.

6. Bars with kinks or with bends not shown shall not be used.

7. Heating or welding bars shall be performed in accordance with AWS D1.4 and shall only be permitted where specified or approved by the ENGINEER. Bars shall not be welded at the bend.

3.06 FIELD QUALITY CONTROL

Field quality control shall include the following:

1. The CONSTRUCTION MANAGER shall be notified 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 ENGINEER.

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 Section 3.01. 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 ENGINEER.

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 03300

CAST-IN-PLACE CONCRETE

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies cast-in-place concrete which consists of furnishing all material, mixing and transporting equipment, and performing all labor for the proportioning, mixing, transporting, placing, consolidating, finishing, and curing of concrete in the structure.

1.02 QUALITY ASSURANCE

A. QUALITY CONTROL BY OWNER:

Special Inspection of concrete work shall be performed by the Special Inspector under contract with the CONTRACTOR 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 concrete 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.

All structural concrete work shall receive Special Inspection in accordance with IBC Chapter 17. Structural concrete includes all 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.

OWNER approved testing shall be in accordance with Section 01400.

B. QUALITY CONTROL BY CONTRACTOR:

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 paragraphs 03300-2.01, 2.02, and 3.15. Costs of testing laboratory services shall be borne by the CONTRACTOR.

C. BASIS FOR QUALITY:

Cast-in-place concrete shall conform to the requirements of ACI 301, except as modified herein.

D. REFERENCES:

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.

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Reference	Title
ACI 117	Tolerances for Concrete Construction and Materials
ACI 211.1	Selecting Proportions for Normal, Heavy Weight and Mass Concrete
ACI 214R	Evaluation of Strength Test Results of Concrete
ACI 301	Structural Concrete for Buildings
ACI 305.1	Specification for Hot Weather Concreting
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 318-14	Building Code Requirements for Structural Concrete
ASTM C31	Making and Curing Concrete Test Specimens in the Field
ASTM C33	Concrete Aggregates
ASTM C39	Compressive Strength of Cylindrical Concrete Specimens
ASTM C40	Organic Impurities in Fine Aggregate for Concrete
ASTM C42	Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C88	Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
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
ASTM C136	Sieve Analysis of Fine and Coarse Aggregates

Reference	Title
ASTM C142	Clay Lumps and Friable Particles in 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 C1567	Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar Bar Method)
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 2015	International Building Code with local amendments

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

1. Each proposed mix design showing (a) the expected strength at 7 and 28 days, (b) corresponding slump before and after the introduction of high-range water-reducing admixtures, (c) water/cement ratios, (d) weights and test results of the ingredients, (e) aggregate gradation, (f) test results of mix design prepared by an independent testing laboratory, and (g) other physical properties necessary to review

each mix design for conformance with these specifications. Mix design proposed shall be sealed by a Professional Engineer registered in the state of Arizona.

2. Product literature and technical data for aggregates, cement, and pozzolan.

3. Product literature, technical data and dosage of all proposed admixtures including, but not limited to, air entraining, water reducing and/or retarding admixtures.

4. Anticipated average delivery time from batch plant to site. If this time exceeds the limit specified in paragraph 3.02, include proposed method to extend set time without deleterious effects on final product. The ENGINEER reserves the right, in their sole discretion, to accept or reject such proposed methods.

5. Curing program description in sufficient detail to demonstrate acceptable strength, finish and crack control as specified.

6. Product literature and technical data for waterstops, curing and sealing compounds, bonding compounds,epoxy and chemical grout for crack injection, and retardant..

7. Samples of concrete floor and slab finishes are specified in paragraph 3.12 E.

8. Concrete delivery truck tickets showing the information listed in ASTM C94, section 14.

9. The CONTRACTOR shall prepare concrete placement drawings. The placement drawings shall include the intended placement sequencing, location of each placement, the size of the concrete placements, joint locations, embedded items, slab high points and low points, and waterstop locations. Each placement shall also be label with a mix design and the type of finish the concrete surface is to receive.

PART 2--PRODUCTS

2.01 MATERIALS

A. CEMENT:

Portland cement shall be ASTM C150, Type II, 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.

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.

Portland-pozzolan cement shall be ASTM C595, Type IP (MS), interground, low alkali.

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 Section 2.01G.

B. GROUND GRANULATED BLAST-FURNACE SLAG:

Ground granulated blast-furnace slag (GGBFS), if used in conjunction with Portland cement, shall be per ASTM C989.

C. AGGREGATES:

1. GENERAL: Except as modified herein, fine and coarse aggregates shall conform to ASTM C33. Fine and coarse aggregates shall be regarded as separate ingredients. Aggregates shall be non-reactive and shall be washed before use.

Aggregates shall be checked 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 when tested in accordance with ASTM C1260 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. ASTM C1260 and ASTM C1567 test results shall be no older than 1 year.

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. The final combined aggregate gradation shall be established during the design mix.

Aggregates used in the 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 Section 2.01G.

2. FINE AGGREGATE: 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.

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

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

3. COARSE AGGREGATE: 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 in paragraph 03300-2.02 A shall conform to ASTM C33, Table 2.

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:

Pozzolan shall be 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 Section 2.01G.

The pozzolan color shall not substantially alter the resulting concrete from the normal gray color and appearance.

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: Admixtures shall be compatible with the concrete and with each other. Calcium chloride or admixtures containing calcium chloride are not acceptable. Admixtures shall be used in accordance with the manufacturer's recommendations and shall be added separately to the concrete mix. The 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 paragraph 3.02.

2. WATER REDUCING ADMIXTURES: Water reducing admixtures shall conform to ASTM C494, Type A. Acceptable products include: BASF "MasterPozzolith 322"; SIKA Chemical Corp. "Plastocrete 161"; Euclid Chemical Co. "Eucon WR91"; or equal.

3. WATER REDUCING AND RETARDING ADMIXTURES: Water reducing and retarding admixtures shall conform to ASTM C494, Type D. Acceptable products include: BASF "MasterPozzolith80"; Sika Chemical Corp. "Plastiment"; Euclid Chemical Co. "Eucon Retarder 75"; or equal.

4. HIGH RANGE WATER REDUCING ADMIXTURES: High range water reducing (superplasticizing) admixtures shall 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 equal.

5. HIGH RANGE WATER REDUCING AND RETARDING ADMIXTURES: High range water reducing and retarding admixtures shall conform to ASTM C494, Type G. Acceptable products include: W.R. Grace "Daracem 100"; Euclid Chemical Co. "Eucon 537"; or equal.

6. AIR ENTRAINING AGENT: Air entraining agent shall conform to ASTM C260. Acceptable products include: BASF "MB-AE 90"; Sika Chemical Corp. "AEA-15"; Euclid Chemical Co. "AEA-92"; or equal. The air entraining agent added shall produce, in accordance with ASTM C260, an entrained air content specified in paragraph 03300-2.02 A for each class of concrete.

F. WATER:

Water for washing aggregate, for mixing and for curing shall be free from oil and deleterious amounts of acids, alkalis, and organic materials; and shall 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:

After each concrete mix design is approved by the ENGINEER, 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:

Concrete shall be normal weight concrete composed of specified cement, pozzolan, admixtures, aggregates and water proportioned and mixed to produce a workable, strong, dense, and impermeable concrete. The CONTRACTOR may 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 in a given mix proportion.

Concrete shall be provided in accordance with the following:

Concrete class	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)	Minimum[a] 28-day compressive strength, psi	Slump Range[d] (inches)
B	57 or 67	0.45	560	15-20[c]	4-6	3000	3-5
C	57 or 67	0.40	560	15-20	4-6	4500	3-5
E[b]	57	--	-	15-20[c]	Not Required	2000	4-8

[a] Compressive strength shall be determined 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 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:

Concrete shall be provided by class for the corresponding use listed as follows:

Type of use	Class of concrete
Non-structural concrete (sidewalks, curbs, pavers, etc.)	B
Typical cast-in-place structural concrete and concrete fill	C

Type of use	Class of concrete
Pipe bedding and encasement, electrical conduit encasement (duct banks)	E

C. CONTROL TESTS:

1. GENERAL: Before beginning concrete work, the CONTRACTOR shall determine the proper proportions of materials for each class of concrete. The mix shall consist of specified cement, pozzolan, admixtures, aggregate and water. Methods for selecting and adjusting proportions of the ingredients shall be 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 method. Concrete shall not be placed in the field prior to review and acceptance of mix proposed.

2. TRIAL MIX DESIGN: Each class of concrete and/or mix verified by this method shall be manufactured at the batch plant which will supply concrete to the project using materials proposed for the Work and material combinations listed in paragraphs 2.01 and 202. Testing, data and reporting shall conform to ACI 318 Section 5.3 and the following:

(a) 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.

(b) Make at least three trial different 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.

(c) Trial mixtures shall be designed to produce a slump within ¾ in. of the maximum specified and for air-entrained concrete, an air content within 0.5% of the maximum allowable air content.

(d) For each w/cm ratio or cementitious materials content, at least twelve standard test cylinders shall be cast and cured in accordance with ASTM C192. Four cylinders from each batch shall be tested at age 7 days, 14 days, and 28 days or as required to comply with ACI 318 Section 5.3.

(e) From results of the cylinder tests, plot a curve showing the relationship between w/cm ratio and compressive strength.

(f) 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 that shall be used unless a lower w/cm ratio is specified in paragraph 2.02A.

3. FIELD EXPERIENCE DATA: 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 Section 5.3, except as modified herein. 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) fine aggregate fraction within +0/ 5 percent of that specified; and (f) slump after introduction of admixtures +0/-1 inch. Use of historical mix design data does not allow modification of the project mix specifications herein without the express review and acceptance of the ENGINEER.

2.03 BONDING COMPOUNDS

Epoxy resin bonding compounds to be used for wet areas shall conform to ASTM C881 Types IV or V, Class A, B, or C depending on temperature at use, and Grade to suit geometry and installation circumstances. Acceptable products include: BASF "Concresive Paste SPL" or "Concresive 1490", as applicable; Sika Chemical Corporation "Sikadur 35" or Sikadur 32", as applicable; or equal.

Non-epoxy bonding compounds may be used in dry areas for non-structural bonding or as specifically noted on the drawings only and shall conform to ASTM C1059 Type II. Acceptable products include: Edoco "Burke Acrylic Bondcrete"; ChemMasters "Cretelox"; or equal.

Bonding compounds shall be applied in accordance with the manufacturer's instructions.

2.06 EPOXY FOR CRACK INJECTION

Epoxy for crack injection shall be a two-component, moisture insensitive, high modulus, injection grade, 100 percent solids, blend of epoxy-resin compounds. The consistency shall be as required to achieve complete penetration in hairline cracks and larger. Material shall conform to ASTM C881 Type 1 Grade 1. Acceptable products include Sika Corporation "Sikadur 52"; Adhesives Technology Corporation "Crackbond SLV302"; or equal. Epoxy grout shall be used for all crack repairs.

2.07 RETARDANT

Retardant for exposing aggregates for unformed surfaces in construction joints shall be Sika "Rugasol-S"; W.R. Grace "Top-Cast"; or equal. Retardant shall be applied in accordance with manufacturer's instructions sufficient to assure a minimum penetration of 1/4 inch.

2.08 CURING AND SEALING COMPOUNDS

Curing and sealing compound shall be BASF ”MasterKure CC 250SB”; Dayton Superior “Cure & Seal 25% J22UV”; or equal conforming to ASTM C309 and ASTM C1315.

Curing compound shall be clear and shall be applied in accordance with the manufacturer’s instructions, except as otherwise specified. Curing and sealing compound shall be certified compliant with final finish systems.

PART 3--EXECUTION

3.01 GENERAL

This section covers the production of cast-in-place concrete. Included are methods and procedures for obtaining quality concrete through proper handling, placing, finishing, curing, and repair of surface defects.

3.02 CONCRETE

Concrete shall be truck-mixed, ready-mixed concrete conforming to the applicable portions of ASTM C94. Materials shall be proportioned by weighing. Pozzolan shall be introduced into the mixer with cement and other components of the concrete mix; pozzolan shall not be introduced into a wet mixer ahead of other materials or with mixing water. Water shall be introduced at the time of charging the mixer; additional water may be introduced within 45 minutes from charging the mixer, provided the specified slump is not exceeded and the maximum total water per the approved mix design is not exceeded. CONTRACTOR shall arrange with the testing laboratory for inspection as required to comply with these specifications.

Concrete shall be delivered to the site and discharge shall be completed 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 ENGINEER.

3.03 CONVEYING AND PLACING CONCRETE

A. CONVEYING CONCRETE:

Concrete shall be conveyed from the mixer to the forms in accordance with ACI 301. Concrete which has segregated in conveying shall be removed from the site of the work.

B. PLACING CONCRETE:

1. GENERAL: Concrete shall be placed in accordance with ACI 301. Do not permit concrete to drop freely more than 4-ft.

2. PLACING CONCRETE BY PUMPING: Concrete may be placed by pumping at CONTRACTOR's discretion. Use of pumping shall not, however, be cause to change or relax specified mix design characteristics. Concrete shall possess the specified characteristics at the point of placement.

Slump shall be measured at the hose discharge, except as follows. Initial slump testing in each pour 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.

Air content shall be measured 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. The air content of the delivered concrete at the inlet hopper shall be increased 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.

Before starting each pumping operation, the pump and line shall be primed with a cement slurry to lubricate the system. Cement slurry shall be wasted outside the forms. Hose tip shall be equipped with a safety chain for recovery in case of hose blowout during pumping, and in no case shall hose or accessories remain in the freshly placed concrete.

Proper tremie placing techniques and equipment shall be used for all 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 CONSTRUCTION MANAGER has verified that the proper equipment is available, in particular, the tremie plug. Should the discharge line become open, with significant zones empty of concrete, then the pumping shall cease and the line re-primed with tremie plug installed before continuing the pour.

3. PLACING CONCRETE IN HOT WEATHER: In hot weather (above 80 degrees F), concrete shall be placed in accordance with ACI 305.1.

4. PLACING CONCRETE IN COLD WEATHER: In cold weather (below 45 degrees F), concrete shall be placed in accordance with ACI 306.1.

C. CONSOLIDATING CONCRETE:

Concrete shall be consolidated in accordance with ACI 301. If proper consolidation is not occurring, then concrete placing shall be suspended until proper consolidation can be achieved.

3.04 CURING AND SEALING

A. GENERAL:

Concrete curing shall be completed by water curing or by using a clear membrane curing compound or by a combination of both methods. Repairs or treatment of concrete surfaces shall be coordinated so that interruption of the curing will not be necessary.

Concrete surface temperature shall be maintained between 50 degrees F and 80 degrees F for at least 5 days. Curing concrete in hot weather (above 80 degrees F) shall be in accordance with ACI 305.1. Curing concrete in cold weather (below 45 degrees F) shall be in accordance with ACI 306.1.

B. WATER CURING:

When water curing is used, concrete shall be kept wet continuously for a minimum of 10 days after placement. Absorptive mats or fabric may be used to retain moisture during the curing period.

Unless otherwise specified, water curing shall be used in hot weather for water containment structures. Forms shall be covered and kept moist. The forms shall be loosened as soon as possible without damage to the concrete, and provisions made for curing water to run down inside them. During form removal, care shall be taken to provide wet cover to newly exposed surfaces.

C. CURING COMPOUND:

When curing compound is used, it shall be applied as soon as the concrete has set sufficiently so as not to be marred by the application or immediately following form removal for vertical and other formed surfaces. Preparation of surfaces, application procedures, and installation precautions shall be followed in strict compliance with the manufacturer's instructions. Curing compound shall be applied at twice the manufacturer's recommended dosage rate in two coats applied perpendicular to each other. Use of curing compound for other than liquid containing structures shall be in accordance with the manufacturer's recommendations.

Curing compound shall not be used on concrete surfaces to be coated, waterproofed, moisture-proofed, tiled, roofed, or where other coverings are to be bonded, unless the curing compound is compatible with the final finish covering or it is removed prior to covering.

3.05 PROTECTION

Concrete shall be protected from injurious action by sun, rain, flowing water, frost and mechanical injury.

Loading green concrete will not be permitted. Green concrete is defined as concrete with less than 100 percent of the specified strength.

Unless otherwise shown on the Drawings, no backfill shall be placed against concrete walls until the concrete has reached the specified strength and the connecting slabs and beams have been cast and have reached the specified strength.

Arrangements for covering, insulating, and protecting concrete in cold weather shall be in accordance with ACI 306.1.

3.06 CONSTRUCTION JOINTS

A. GENERAL:

Concrete in each unit of construction shall be placed continuously. Before new concrete is placed on or against concrete which has set, forms shall be retightened and the surface of the set concrete shall be cleaned of foreign matter. Watertight joints shall be provided as specified in paragraph 03300-3.09.

B. CONSTRUCTION:

Construction joints shall be formed as specified. A rough surface of exposed concrete aggregates shall be produced using a surface retardant at construction joints, including 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, retarded surface mortar shall be removed either by high pressure water jetting or stiff brushing or combination of both so as to expose coarse aggregates. 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 shall expose coarse aggregate to ensure adequate bond and watertightness at the construction joints.

Reinforcing steel shall be continued across construction joints.

3.07 INSERTS AND EMBEDMENTS

A. INSERTS:

Where pipes, castings or conduits are to pass through structures, the CONTRACTOR shall place such pipes or castings in the forms before placing the concrete, or he may provide openings in the concrete for subsequent insertion of such pipes, castings or conduits. Such openings shall be provided with waterstops and V-shaped construction joint as shown and shall have a slight flare to facilitate grouting and permit the escape of entrained air during grouting.

Additional reinforcement shall be provided around openings as shown. Grout fill around inserts shall be non-shrink grout as specified in Section 03600.

Horizontal conduits and pipes, where shown in structural slabs and beams, shall be placed between the top and bottom layers of reinforcement. Spacing and size limitations shall conform to ACI 318 Section 6.3 unless specifically approved otherwise by the ENGINEER. Such conduits and pipes shall not run directly beneath a column or, if used, its steel base plate. Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be so positioned and supported prior to placement of concrete that there will be a minimum of 2-inches clearance between said items and any part of the concrete reinforcement. The outside diameter of such

conduits should not exceed one-fourth the slab or beam thickness. Securing such items in position by welding them to the reinforcement will not be permitted.

B. EMBEDMENTS:

Miscellaneous metal parts that are to be embedded in the concrete shall be set and secured in the forms prior to concrete placement. Unless otherwise specified, anchor bolts and inserts shall be embedded in concrete as shown. The CONTRACTOR shall provide inserts, anchors or other bolts necessary for the attachment of piping, valves, metal parts and equipment. Nailing blocks, plugs, strips, and the like necessary for the attachment of trim, finish, and similar work shall be provided. Voids in sleeves, inserts and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids. Operators or sleeves for gate or valve stems shall be positioned to clear reinforcing steel, conduit and other embedments, and to align accurately with equipment.

3.08 FORMED SURFACE FINISHES

A. REPAIR OF SURFACE DEFECTS:

Surface defects, including tie holes, minor honeycombing or otherwise defective concrete shall be repaired in accordance with ACI 301. Areas to be patched shall be cleaned. Minor honeycombed or otherwise defective areas shall be cut out to solid concrete to a depth of at least 1 inch. The edges of the cut shall be perpendicular to the surface of the concrete. Patches on exposed surfaces shall be finished to match the adjoining surfaces after they have set. Patches shall be cured as specified for the concrete. Finished surfaces shall be protected from stains and abrasions. Finishes shall be equal in workmanship, texture, and general appearance to that of the adjacent concrete. Concrete with honeycombing which exposes the reinforcing steel or with defects which affect structural strength shall be corrected.

B. FORMED SURFACE FINISHING:

Formed surfaces shall be finished as soon as practicable after form removal and repair of surface defects. Finishes shall be as follows.

1. FINISH A: Finish A shall be a grout-cleaned rubbed finish in accordance with ACI 301 except that ALL FORM FINS AND OTHER PROTRUSIONS SHALL BE COMPLETELY REMOVED TO THE FINAL SURFACE. Surfaces shall be lightly sandblasted prior to sacking. Sandblasting shall occur after the specified curing period. For interior areas not exposed to moisture or weather, water used in the sacking mortar shall be mixed with a PVA bonding compound as recommended by the manufacturer. Finish A shall be provided for interior surfaces of equipment roomsand permanently exposed vertical and sloped surfaces. Finish A shall not be provided at concrete surfaces receiving a coating.

2. FINISH B: Finish B shall be a smooth surface with all form fins and other protrusions completely removed to the final surface. Finish B shall be provided for coated surfaces.

See specification 09900 for concrete surface coatings and surface preparation, including filling bug holes before coating.

3. FINISH C: Finish C shall be a finish which has surface imperfections less than 3/8 inch in any dimension. Surface imperfections greater than 3/8 inch shall be repaired or removed and the affected areas shall be neatly patched. Finish C or smoother shall be provided for interior surfaces of wet wells, tanks and channels from 1 foot below minimum water surfaces and down and otherwise unfinished interior surfaces.

4. FINISH D: Finish D shall be the finish for surfaces which may be left as they come from the forms, except that tie holes shall be plugged and defects greater than 1/2 inch in any dimension shall be repaired.

C. SAMPLES OF FORMED SURFACE FINISH:

A sample concrete panel, 2 feet by 2 feet, representative of formed surface Finish A shall be provided to the CONSTRUCTION MANAGER. The panel shall be representative of the workmanship and finish required, including filling of tie holes. The sample shall be deemed acceptable by the CONSTRUCTION MANAGER prior to the start of such work. The sample shall be on display at the job site, and finished surfaces shall match sample.

3.09 SLAB FINISHES

A. GENERAL:

The finishes specified herein include surface finishes, treatments and toppings for floors and slabs. Dry cement shall not be used on new concrete surfaces to absorb excess moisture. Edges shall be rounded to a radius of 1/2 inch. Joints shall be grooved to a radius and depth of 1/4 inch each. Finishes shall match the sample panels provided under paragraph 03300-3.12E.

Floors shall be sloped 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. Where finish is not specified, floor slabs shall receive steel troweling. Use of floor drains with only locally depressed slabs shall be coordinated with CONSTRUCTION MANAGER if detailed on the drawings, and restricted to locations specifically noted.

B. FLOAT FINISH:

Floating shall be performed 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 to permit operation of the specific float apparatus. Floating of any one area shall be the minimum necessary to produce a finish that will meet tolerance requirements of ACI 117 for a conventional surface. Refloat the slab immediately to a uniform texture. Floating shall compact and smooth the surface and close any cracks and checking of surfaces. Float finish shall be applied to surfaces of channel, tank bottom slabs, tops of footings, and steps and surfaces to receive roofing and insulation.

C. STEEL TROWEL FINISH:

Float the concrete surface and then trowel in accordance with ACI 301. Immediately after final troweling, the surface shall be cured and protected as specified in paragraphs 03300-3.04 and 03300-3.05. Steel trowel finish shall be provided on floors unless specified otherwise.

D. BROOMED FINISH:

Immediately after concrete has received a floated finish, give the concrete surface a coarse transverse scored texture by drawing a broom or burlap belt across the surface in accordance with ACI 301. Broomed finish shall be provided for walks, slabs-on-grade exposed to atmosphere, and where otherwise indicated or specified.

E. SAMPLES OF CONCRETE FLOOR FINISHES:

A sample concrete panel, 2 feet by 2 feet, representative of each specified finish, shall be provided to the CONSTRUCTION MANAGER. The panels shall be representative of the workmanship and finishes required. Samples shall be approved in field prior to the start of such work.

3.10 RELATED SURFACES

A. FINISHING OF UNFORMED SURFACES:

1. RELATED UNFORMED SURFACES: Tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed and shall be floated to a texture reasonably consistent with that of the adjacent formed surfaces. Final treatment of formed surfaces shall continue uniformly across the unformed surfaces.

2. PAVEMENTS AND SIDEWALKS: The surfaces of the concrete shall be screeded to grade and sloped to drain. After screeding, the surface shall receive a broomed finish as specified in paragraph 03300-3.12 D. Edges and expansion joints shall be rounded to a radius of ½ inch. Joints shall be grooved to a radius and depth of 1/4 inch each.

3.11 FIELD SAMPLING AND TESTS

A. GENERAL:

Field sampling and testing shall be performed by the independent testing laboratory. Samples of aggregates and concrete shall be taken at such times to represent the quality of the materials and work throughout the project. The laboratory shall provide the necessary labor, materials and facilities for sampling the aggregate and for casting, handling and initially storing the concrete samples at the site of work. Aggregates shall be sampled in accordance with paragraph

03300-3.14 B not less than 30 days prior to the use of such aggregates in the work. The minimum number of samples and tests are specified in paragraph 03300-3.14 C.

B. SAMPLING:

1. AGGREGATES:

a. GENERAL: Fine and coarse aggregates shall be sampled in accordance with ASTM D75. Samples shall be taken at the discharge gates of the bins feeding the weigh hopper. The CONTRACTOR shall provide safe and suitable facilities for obtaining samples. Samples shall be obtained at the concrete batch plant at the frequency specified in paragraph 03300-3.14 C. Sampling shall be repeated when the source of material is changed or when unacceptable deficiencies or variations from the specified requirements of materials are found in testing. Aggregate samples shall be tagged and their sources identified.

b. COARSE AGGREGATE: A sample weighing between 50 and 60 pounds shall be taken after the batch plant is brought up to full operation. The samples shall be taken so that a uniform cross section, accurately representing the materials on the belt or in the bins, is obtained.

c. FINE AGGREGATE: Samples shall be taken as specified for coarse aggregate. The samples shall be taken for sieve analysis of fine aggregate and specific gravity tests. Samples of sand shall be taken when the sand is moist.

2. CONCRETE: Samples of plastic concrete shall be obtained in accordance with ASTM C172. Samples shall be taken at the hopper of concreting equipment or transit mix truck, except as noted in 03300-3.03B.2

C. TESTING:

1. AGGREGATE: A minimum of one test of coarse aggregate per 400 cubic yards of concrete 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. A maximum of one test per day of each aggregate is required. The full test program is required before source changes will be accepted.

2. CONCRETE:

a. STRENGTH TESTS: 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.

Standard cylinders 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 surface area placed per day. Casting, handling

and curing of cylinders shall be in accordance with ASTM C31. Additional cylinders shall be provided when an error in batching is suspected. For the first 24 hours after casting, the cylinders shall be kept 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 cylinders shall be transported to the testing laboratory.

Testing of specimens for compressive strength shall be in accordance with ASTM C39. Tests shall be made at 7 and 28 days from time of casting. Two 6 x 12 inch (or three 4 x 8 inch) test cylinders from each group of six (or nine) shall be tested at the end of 7 days and two 6 x 12 inch (or three 4 x 8 inch) shall be tested at the end of 28 days. The two remaining 6 x 12 inch (or three 4 x 8 inch) cylinders shall be tested at the end of 56 days if the 28-day strength reports below specification. A strength test shall consist of the average strength of two 6 x 12 inch (or three 4 x 8) cylinders cast from material taken from a single load of concrete. 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 CONSTRUCTION MANAGER.

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 and not more than 10 percent of the 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.

Certified reports of the test results shall be provided directly to the CONSTRUCTION MANAGER. Test reports shall include sufficient information to identify the mix used, the stationing or location of the concrete placement, and the quantity placed. Slump, air content, temperature of concrete, and ambient temperature shall be noted. 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 job and shall be available for the CONSTRUCTION MANAGER's inspection at any time.

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. Changes and adjustments shall be reported in writing to the CONSTRUCTION MANAGER.

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 CONSTRUCTION MANAGER. Costs of such tests shall be borne by the CONTRACTOR.

b. TESTS FOR CONSISTENCY OF CONCRETE. The slump shall be as specified when measured in accordance with ASTM C143. Samples for slump determination shall be taken from the concrete during placement. Tests shall be made at the beginning of concrete

placement operation and at subsequent intervals to ensure that the specification requirements are met. Slump tests shall also be performed whenever standard cylinders are cast. For pumped concrete, slump shall be measured in accordance with paragraph 3.03B.2.

When high range water reducers are added at the site, slump tests shall be taken before and after addition of high range water reducing admixtures.

c. TESTS FOR TEMPERATURE AND AIR CONTENT:

Temperature tests shall be made at frequent intervals during hot or cold weather conditions until satisfactory temperature control is established. Whenever standard cylinders are cast, temperature tests shall be performed.

Air content shall be as specified when measured in accordance with ASTM C231. Air content shall be measured whenever standard cylinders are cast. For pumped concrete, air content shall be measured in accordance with paragraph 3.03B.2.

D. FINAL LABORATORY REPORT:

A final report, prepared by the testing laboratory, shall be provided 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. Final quality control charts for compressive strength tests for classes of concrete specified in each major structure shall be included. The report shall also include the concrete batch plant's coefficient of variation and standard deviation results for each class of concrete.

3.14 REPAIR OF DAMAGED CONCRETE, CRACKING:

A. ACCEPTANCE OF CONCRETE:

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 the requirements of ACI 301 or the Contract Documents shall be repaired as approved by the ENGINEER to bring the concrete into compliance. Concrete that cannot be brought into compliance by approved repair methods will be rejected. Rejected concrete work shall be removed and replaced. Repair methods shall be in accordance with ACI standards and are subject to the approval of the ENGINEER. The cost of repairs and replacement of defective concrete shall be borne by the CONTRACTOR.

B. REPAIR METHODS:

Damaged or excessively cracked concrete, as determined by the ENGINEER in their sole discretion, shall be repaired by one of the following methods as approved by the ENGINEER:

1. Repair Method 1: Fill the joint or crack by drilling holes to the affected area, install injection ports and force epoxy or chemical grout (expanding urethane) into the joint under pressure. The material type, whether epoxy or chemical grout shall be approved by the ENGINEER. After injection and

curing, ports, sealing mix and surface generally shall be cleaned and worked to match the specified finish.

2. Repair Method 2: 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. At a minimum, prepare surface to result in a clean, dry surface and with no visible detrimental material in cracks to be filled. Conform to temperature limitations for epoxy to be used. Finish to match adjacent areas.

3. Repair Method 3: Cut a bevel groove 3/8 to 1/2 inch in width and depth, and caulk with sealant in accordance with manufacturer's instructions. This repair method is only to be used where expressly allowed by the ENGINEER. Groove and caulk shall be applied on wet or hydrostatic pressure side of surface where occurs.

C. REPAIR METHOD USE:

1. Repair Method 1 shall be used for all cracks in walls, surfaces sloped 1:1 or greater, beams, columns, slabs, overhead surfaces and generally for liquid retaining surfaces. Need for repair depends upon crack width, location, and surface conditions under service conditions. Epoxy grout shall be used for repair of structural cracks and chemical grout (expanding urethane) shall be used for repair of non-structural cracks at liquid-containing structures. The ENGINEER shall determine whether a crack is classified as structural or non-structural.

2. Repair Method 2 may be utilized in lieu of Method 1 for slabs which receive a raked finish. Method 2 may also be used with CONSTRUCTION MANAGER's approval for exposed troweled and broomed finishes after review of conditions, degree of exposure to public, and proposed repair product and installation. Finish shall substantially match adjacent surfaces.

3. Repair Method 3 shall be limited to dry-surface slabs, walls subject to less than three feet of liquid pressure, or as specifically directed by the ENGINEER. Method 3 is not an equivalent repair method to Methods 1 or 2, which shall be considered the standards.

3.15 CLEANUP

Upon completion of the work and prior to final inspection, the CONTRACTOR shall clean all concrete surfaces. The cleaning procedures shall be as follows: After sweeping with an ordinary broom to remove the loose dirt, the surface shall be flushed with clean water. Final scrubbing by hand or machine shall follow.

Floors that have curing and sealing compound shall be cleaned of loose dirt and debris by sweeping with ordinary brooms. They shall then be washed and mopped with clean water. Finally, one additional coat of the same clear curing and sealing compound shall be applied in the same manner as specified.

END OF SECTION

SECTION 03481

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 03200 - Concrete Reinforcement

B. Section 03300 - Cast-In-Place Concrete

1.03 REFERENCES

Reference	Title
ASTM C150	Portland Cement
ASTM C207	Hydrated Lime for Masonry Purposes
ASTM C858	Underground Precast Concrete Utility 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
CRSI 63	Recommended Practice for Placing Reinforcing Bars
ASCE 7	Minimum Design Loads and Associated Criteria for Buildings and Other Structures

1.04 DESIGN

A. All vaults shall be designed by a licensed professional engineer registered in the State of Utah and engaged by the manufacturer. All dead loads, live loads, soil 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 grade and the design shall provide for a 1.5 factor of safety against floatation.

E. Below grade vault design shall include static and dynamic effects due to soil loading per ASCE 7.
   1. Minimum static soil design loads shall be taken as 100 psf / foot of depth per ASCE 7, Table 3.2-1, note c.

F. The Vault shall be designed for H-20 wheel load on top slab, hatch, and surcharge loading at grade around all sides of the vault.

1.05 SUBMITTALS

A. Submit evidence that shows current PCI, NPCA, and/or UDOT 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 C858.

D. Submit catalog cut and installation details for aluminum hatches

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 UDOT-certified plant for production of precast vaults as specified herein.

B. Aggregate used in producing concrete shall be from UDOT 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 03200.

2.03 PRECAST CONCRETE BASES

A. Design and manufacture of precast concrete bases shall conform to the requirements of this section and ASTM C858.

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.

2.04 PRECAST CONCRETE WALLS

A. Design and manufacture of precast concrete walls shall conform to the requirements of this section and ASTM C858.

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 C858. 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 03300.

2.06 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.

2.07 HATCHES

A. Hatches shall be of the size and type shown on the Drawings and as described herein.
   1. Aluminum double 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.
   4. Aluminum hatches shall be Bilco "PCM" or as manufactured by Washington Aluminum Company or equal.

2.08 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.

2.09 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.

2.10 EPOXY COATING

A. The interior surface of the vault 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.

END OF SECTION

SECTION 03600

GROUT

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies grout for columns and other structural support bases, equipment bases, crack repair, surface repair and uses other than masonry. Grout for masonry is specified in Section 04200.

1.02 QUALITY ASSURANCE

A. QUALITY CONTROL BY OWNER:

The CONTRACTOR will pay and provide special inspection and testing in accordance with Section 01400.

B. QUALITY CONTROL BY CONTRACTOR:

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, then to demonstrate equivalence with the grout properties of the specified product, 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 the proposed grout materials. Costs of testing laboratory services shall be borne by the CONTRACTOR.

C. REFERENCES:

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 C230	Standard Specification for 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 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	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1181	Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts
COE CRD-C611	Flow of Grout for Preplaced Aggregate Concrete
COE CRD-C621	Specification for Nonshrink Grout
IBC	International Building Code, 2015 edition

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

1. Complete product literature and installation instructions for epoxy grout (all uses) and cementitious non-shrink grout.

2. Current ICC Evaluation Report for adhesives used for reinforcing dowels and anchor setting.

3. Installer certification in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program for installers of horizontal or upwardly inclined adhesive anchors.

PART 2--PRODUCTS

2.01 CEMENTITIOUS NONSHRINK GROUT

1. 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.

2. Cementitious nonshrink nonmetallic aggregate grout shall be Five Star Products, Inc. Five Star Grout, BASF Masterflow 928, Hi-Flow Grout by Euclid Chemical Company, SikaGrout 212 by Sika Corporation, or approved equal.

3. 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.

4. Fluid grout shall pass through the flow cone, with continuous flow, one hour after mixing.

2.02 EPOXY GROUT FOR EQUIPMENT MOUNTING

Epoxy grout for equipment mounting shall be a non-cementitious, resin based, multi-component formulation and shall be a pourable, non-shrink, 100 percent solids system. Epoxy grout shall be flowable, with shrinkage minimized to achieve minimum 98% effective bearing area. Epoxy grout shall be BASF Masterflow 648; Sikadur 42 by Sika Corporation; E3-G by Euclid Chemical Company; or approved equal.

2.03 ADHESIVE FOR DOWEL AND ANCHOR SETTING

Adhesive for setting dowels and anchoring connection/base plate bolts shall be an injectable two-component epoxy adhesive. Adhesive shall be approved for the intended use per the product ICC Report.

Adhesive shall be HIT-RE 500V3 by Hilti or approved equal (equivalent product must have ICC approval for use in cracked concrete in areas with high seismic risk) for setting dowels in concrete.

Adhesive shall be HILTI HIT-HY 270 or approved equal for setting dowels in masonry.

2.04 CONCRETE REPAIR MORTAR

Horizontal Applications: Horizontal repair mortars shall be MasterEmaco S466 CI by BASF, SikaTop 111 Plus by Sika Corp, or approved equal.

Vertical and Overhead Applications: Vertical and overhead repair mortars shall be SikaTop 123 Plus or approved equal.

PART 3--EXECUTION

3.01 CEMENTITIOUS NONSHRINK GROUT

Nonshrink, 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 11002 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 manufacturer's instructions.

Nonshrink cementitious grout shall not be used as a surface patch or topping. Nonshrink cementitious grout must be used in confined applications only.

3.02 EPOXY GROUT FOR EQUIPMENT MOUNTING

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 11002, details on the Drawings, and in strict conformance with manufacturer’s recommendations.

3.03 CONCRETE REPAIR MORTAR

Concrete repair materials and procedures shall be submitted for review to the ENGINEER and shall be accepted prior to commencement of the repair work.

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 ENGINEER and shall be accepted prior to commencement of the work.

END OF SECTION

Navajo Nation
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

CAMERON PUMP STATIONS AND PRESSURE RELIEF VALVES

DIVISION 4

MASONRY

04200 Unit Masonry

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SECTION 04200

UNIT MASONRY

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies masonry work consisting of reinforced concrete masonry construction. Masonry work shall be constructed from concrete masonry units in combination with reinforcement, mortar, and grout as specified.

B. TYPE:

Masonry work shall be constructed from units of concrete in combination with reinforcing, mortar, and grout as specified.

1.02 QUALITY ASSURANCE

A. REFERENCES:

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.

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
ACI 530-10	Building Code Requirement for Masonry Structures
ACI 530.1-10	Specification for Masonry Structures

Reference	Title
ACI SP-66	ACI Detailing Manual
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
ASTM E514	Water Penetration and Leakage Through Masonry
IBC 2015	International Building Code

B. QUALITY ASSURANCE BY OWNER:

Special inspection of masonry work shall be performed by the Special Inspector under contract with the CONTRACTOR and in accordance with IBC Chapter 17.

C. SAMPLE PANEL:

A sample masonry panel for each type of masonry, approximately 6 feet long by 4 feet high shall be constructed on site for approval by the Construction Manager. Each panel shall show the workmanship, coursing, bond, anchors, joint reinforcing wall ties, tooling of joints, range of color, texture of masonry, and mortar color. Finished work shall match the approved sample panel.

D. APPEARANCE:

Source or supply of materials shall not be changed after the work has started if the appearance of the finished work would be affected.

E. EFFLORESCENCE TESTING:

Certified efflorescence test reports shall be provided on masonry units that are to be exposed to weathering. Schedule tests far enough in advance of starting masonry work to permit retesting if necessary. Test three pairs of specimens of each type of masonry unit for efflorescence in accordance with ASTM C67. If any pair is rated "effloresced," the units represented by the samples will be rejected.

F. PRISM TESTS:

Compressive strength of masonry, f'm, shall be 2000 psi. The compression strength shall be based on the Prism Test Method in accordance with the 2015 IBC and ACI 530.1. Tests for material compression strength shall be as follows:

1. Prior to construction, perform the following tests using samples of materials which will be incorporated into the work.

   a. One prism test consisting of three test specimens constructed and tested in accordance with ASTM C1314.

   b. One mortar test consisting of one set of three specimens constructed and tested in accordance with ASTM C780.

   c. One grout test consisting of one set of three specimens constructed and tested in accordance with ASTM C1019.

1.03 SUBMITTALS

Submittals shall be provided in accordance with Section 01300 and shall include the following information:

A. Masonry unit certificates showing compliance to the specifications shall be submitted for each type of masonry unit.

B. Reinforcing certificates showing compliance to the specifications shall be submitted for reinforcing steelas specified herein and in Section 03200.

C. Certified efflorescence test reports specified in paragraph 04200-1.02 D.

D. Provide scaled fabrication and field layout drawings for all required masonry. Drawings to include reinforcing, positioning devices, and other accessories.

E. Mix designs for each type of mortar and grout. Include description of type and proportions of ingredients.
   a. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive

strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.

b. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

F. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

G. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.04 DELIVERY, STORAGE, AND HANDLING:

Cementitious materials shall be delivered to the site in unbroken containers, plainly marked and labeled with manufacturers' names and brands, stored in dry, weathertight enclosures to prevent entry of foreign materials and damage by water or dampness. Masonry units shall be stored off the ground and handled with care to avoid chipping and breakage. Materials shall be protected from damage and, except for sand, kept dry until used. Sand shall be covered to prevent intrusion of water and foreign materials and to prevent drying. Materials containing frost or ice shall not be used. Store masonry accessories, including metal items, in such a manner to prevent corrosion and accumulation of dirt and oil.

PART 2--PRODUCTS

2.01 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.

2. Provide square-edged units for outside corners unless otherwise indicated.

B. CMUs: ASTM C 90.

1. Density Classification: Medium weight.

2. Size: Manufactured to dimensions 3/8 inch less than nominal dimensions.

3. Nominal width: 8 inches; Nominal height: 8 inches; Nominal length: 16 inches.

C. CMU TYPES SCHEDULE:

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.

D. MASONRY LINTELS:

Masonry lintels shall be made from special CMUs shapes with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.02 MORTAR

A. MORTAR TYPE:

Mortar shall be ASTM C270, Type S. The mortar shall be proportioned to achieve a minimum 28-day compressive strength of 2,800 psi. Where colored mortar is specified to match the masonry units, add colorant to obtain the color indicated. Colorant shall be alkali-resistant iron oxide based and shall be Sonneborn "Sonobrite," Solomon Grind-Chem Service, Inc., "Concentrated Cement Color," or equal.

B. CEMENT:

Cement shall be Portland cement conforming to ASTM C150, Type II, low alkali containing less than 0.60 percent alkalies.

C. HYDRATED LIME:

Hydrated lime shall conform to ASTM C207, Type S.

D. MASONRY CEMENT:

Masonry cement shall not be used.

E. SAND:

Aggregate for mortar shall be sand conforming to ASTM C144. Sand must be clean and washed.

F. WATER:

Water shall be clean, potable, and free from substances which could adversely affect the mortar.

G. PREMIXED MORTAR:

Premixed mortar shall be ASTM C270, Type S for use as specified in paragraph 04200-2.02 G.

H. ADMIXTURES:

Admixtures may be used in mortar to retard curing and provide up to 36 hours of work-ability, provided that the admixture does not adversely affect bonding or compressive strength.

2.03 ACCESSORIES

A. REINFORCING BARS:

Reinforcing steel shall be as specified in Section 03200.

B. THROUGH-WALL FLASHING:

Flashing, where specified, shall be 5-ounce, electrolytic copper sheet, uniformly coated on both sides with acidproof, alkaliproof, elastic bituminous compound. Factory applied coating shall weigh not less than 6 ounces per square foot (approximately 3 ounces per square foot on each side).

C. REINFORCING BAR POSITIONERS

Rebar positioners shall be of 9-gauge wire with a mill galvanized finish as manufactured by Hohmann & Barnard, Inc. or equal. Rebar positioners are to be sized to fit masonry unit.

2.04 GROUT

A. GENERAL:

Grout shall comply with ASTM C476, shall use Type II cement, and shall be proportioned by volume to achieve a minimum 28-day compressive strength of 2,000 psi. Grout shall have sufficient water added to produce a consistency for pouring without segregation.

B. AGGREGATE:

Aggregate shall comply with ASTM C404.

C. FINE GROUT:

Fine grout shall be composed of one part cement, not more than 1/10 part lime, and 2 1/4 to 3 parts fine aggregate.

D. COARSE GROUT:

Coarse grout shall be composed of one part cement, not more than 1/10 part lime, 2 to 3 parts fine aggregate, and not more than 2 parts coarse aggregate.

2.05 EMBEDDED FLASHING MATERIALS, WEEPS, AND CAVITY DRAINAGE

A. Flexible Flashing: Use one of the following unless otherwise indicated:

1. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040 inch.

a. Products: Subject to compliance with requirements, provide one of the following:

1) Carlisle Coatings and Waterproofing; CCW-705-TWF Thru-Wall Flashing
2) Grace Construction Products, W.R. Grace & Co. – Conn.; Perm-A-Barrier Wall Flashing
3) Henry Company: Blueskin TWF.

b. Accessories: Provide preformed corner, end dams, other special shapes, and seaming material produced by flashing manufacturer.

c. Application: Unless otherwise indicated, use the following:

1) Where flashing is fully concealed, use flexible flashing.

C. 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.

D. Vinyl Weep Hole/Vent: One-piece, offset, T-shaped units made from flexible, injection-molded PVC, designed to fit into a head joint and consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and top flap to keep mortar out of the head joint; in color approved by Architect to match that of mortar.

1. Available Products:

    a. Hohmann & Barnard, Inc.; #341 Weep Hole
    b. Williams Products, Inc.; Williams-Goodco Brick Vent.
    c. Wire-Bond; Louvered Weepholes

E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Provide one of the following configurations

    a. Strip, full-depth of cavity and 10 inches wide, with dovetail shaped notches 7 inches deep that prevent mesh from being clogged with mortar droppings.

2. Available Products:

    a. Advanced Building Products, Inc.; Mortar Break II..
    b. Mortar Net USA, ltd.; Mortar Net.
    c. Hohmann & Barnard, Inc.; Mortar Trap.

2.06 WATER REPELLENT

A. Water repellent coating on masonry wall faces exposed to weather: FABRISHIELD 653 siloxane/quartz water repellent as manufactured by Fabrikem Manufacturing Ltd.

PART 3--EXECUTION

3.01 PREPARATION

A. GENERAL:

Foundations for masonry work shall be straight, on-line, and level. All surfaces to be bonded with masonry shall be clean and free from laitance or foreign materials. Reinforcing dowels shall be in the correct location as specified. The placement and location of anchor ties, inserts, and other embedded items in concrete or other adjoining work shall be coordinated by the Contractor to suit the masonry work.

B. PROTECTION:

1. Exposed surfaces shall be protected from mortar and other stains. When mortar joints are tooled, remove mortar from exposed surfaces with fiber brushes and wooden paddles. Base of walls shall be protected from splash stains by covering adjacent ground with sand, sawdust, or polyethylene.

2. Uniform loads shall not be applied for at least 48 hours or concentrated loads for at least 72 hours after masonry is constructed.

3. Temporary bracing shall be provided as required to prevent damage during construction.

4. Protective boards for polyester film shall be provided during job installation to ensure no damage from building debris.

5. Protect masonry construction to prevent efflorescence. Take measures to eliminate moisture from entering walls tha have not received parapet coping or coatings. Remove all efflorescence prior to applying water repellents.

3.02 WORKMANSHIP

Masonry shall be level and plumb. Story poles or gage rods shall be used 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. Unfinished work shall be stepped back for joining with new work; toothing will not be permitted. Heights of masonry at each floor and at sills and heads of openings shall be checked with an instrument to maintain the level of the walls. Door and window frames, louvered openings, anchors, pipes, ducts, and conduits shall be built in as the masonry work progresses. Spaces around metal door frames shall be filled solidly with mortar. Drilling, cutting, fitting, and patching to accommodate the work of others shall be performed by masonry mechanics. Masonry shall be cut with masonry saws for exposed work. Structural steelwork, bolts, anchors, inserts, plugs, ties, lintels, and miscellaneous metalwork shall be placed in position as the work progresses. Chases of approved dimensions for pipes and other purposes shall be provided where specified and necessary. Tops of exposed walls and partitions not being worked on shall be covered with a waterproof membrane secured in place and extended down at least 2 feet on both sides.

3.03 MORTAR MIXING

Mortar materials shall be measured in 1 cubic foot containers to maintain control and accuracy of proportions; measuring materials with shovels is not permitted. Mortar shall be mixed in a mechanical batch mixer for not less than 3 nor more than 5 minutes after all ingredients are in so as to produce a uniform mixture. Water shall be added 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.

Mortar shall be mixed in accordance with ASTM C270 to obtain type mortar required. Where colored mortars are required, pigments may be added at the site or provided as part of prepackaged mortar mix.

3.04 MORTAR JOINTS

Mortar joints shall be a uniform thickness of 3/8-inch unless otherwise specified. Exposed joints shall be tooled 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, jointers shall be at least 12 inches long for brickwork and 16 inches long for concrete masonry. 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. Joints that will not be exposed shall be struck flush. Vertical joints shall be tooled first. Horizontal joints shall be level; vertical joints shall be plumb and in alignment from top to bottom of wall within a tolerance of plus or minus 1/2 inch in 40 feet.

3.05 TOLERANCES

Masonry work shall be within the following limits:

1. Face of Concrete Masonry Unit: 1/16 inch from face of adjacent unit.

2. Variation from True Plane: 1/4 inch in 10 feet and 1/2 inch maximum in 20 feet or more.

3. Variation from Plumb: 1/4 inch in each story, noncumulative and 1/2 inch maximum in two stories or more.

4. Variation from Level: 1/8 inch in 3 feet, 1/4 inch in 10 feet, and 1/2 inch maximum.

5. Variation in Wall Thickness: Plus or minus 1/4 inch.

3.06 CONCRETE MASONRY UNIT WORK

A. GENERAL:

The first course shall be laid in a full bed of mortar for the full width of the unit. Succeeding courses shall be laid in running bond unless otherwise specified. Bed-joints shall be formed 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 about 1 inch to the ends of the adjoining units. The mortar shall be of such thickness that it will be forced out of the joints as the units are placed in position. Where anchors, bolts, and ties occur within the cells of the units, metal lath shall be placed in the joint at the bottom of such cells and the cells filled with mortar or grout as the work progresses. Concrete masonry units shall not be dampened before or during laying.

B. SPECIAL CONCRETE MASONRY UNIT WORK:

Where exposed concrete masonry unit walls are specified, special concrete masonry unit work shall be provided. Units shall be selected for uniformity of size, texture, true plane, and undamaged edges and ends of exposed surfaces. Units shall be placed plumb, parallel, and with properly tooled joints of maximum 3/8-inch thickness, and exposed surfaces kept clean and free from blemishes or defects.

C. REINFORCED CONCRETE MASONRY UNIT WALLS:

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.

3.07 BONDING AND ANCHORING

Walls shall be structurally bonded and anchored to each other.

In addition, bonding and anchoring shall comply with the following procedures unless otherwise specified.

1. At corners of load-bearing walls, provide a true masonry bond in each course.

3.08 CONCRETE MASONRY UNIT LINTELS AND BOND BEAMS

Special units, lintels, and bond beams shall have cells filled solidly with grout or concrete, and provided with not less than two No. 5 reinforcing bars, unless otherwise specified on the drawings. Reinforcing shall overlap a minimum of 40 bar diameters at splices, unless otherwise specified on the drawings. Bond beams and reinforcing shall terminate 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. Bond beam units shall be produced 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. Lintels shall set at least 7 days before shoring is removed.

3.09 GROUT

A. GENERAL:

Fine grout shall be provided 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 3/4 inch. Coarse grout shall be provided 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:

Grout shall be placed from the interior side of walls, except as approved otherwise. Sills, ledges, offsets, and other surfaces shall be protected from grout droppings. Prior to grouting, the grout space shall be clean 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. Grout shall be placed in a continuous pour in grout lifts not exceeding 6 feet. At grout pours exceeding 6 feet, cleanouts shall be provided in the bottom course at every vertical bar but shall not be spaced more than 32 inches on center for solidly grouted masonry. Pours shall be 1-1/2 inches below the top of masonry units in top course, except at the finish course. Grout shall be agitated thoroughly to eliminate voids. Masonry displaced by grouting operation shall be removed and relaid in alignment with fresh mortar.

3.10 FLASHING, WEEPS, AND CAVITY DRAINAGE MATERIAL

A. General: Install embedded flashing, weeps, and cavity drainage in masonry at lintels, ledged, other obstructions to downward flow of water in wall, and where indicated. Install above door and window openings.

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 as recommended by flashing manufacturer.

2. At lintels, extend flashing a minimum of 6 inches into a masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.

3. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.

C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

D. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer’s written instructions with weep spouts aligned with face of wall.

E. Install weep holes in head joints in head joints in exterior withes of first course of masonry immediately above embedded flashing and as follows:

1. Use specifies weep/vent product to form weep holes.

2. Space weep holes 32 inches o.c. unless otherwise indicated.

Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material. Install as per manufacturer's recommendation for conditions encountered on this project.

3.11 FORMS AND SHORING

Contractor shall construct forms to the shape, lines, and dimensions of members indicated and make sufficiently rigid to prevent deflections which may result in cracking or other damage to supported masonry. Forms shall not be removed until members have cured.

3.12 CLEANING

Contractor shall protect work which may be damaged, stained, or discolored during cleaning operations.

Exposed masonry surfaces shall be cleaned with clear water and stiff fiber brushes and rinsed with clear water. Where stains, mortar, or other soil remain, scrubbing shall continue with warm water and detergent. Immediately after cleaning, each area shall be rinsed thoroughly with clear water. Damaged, stained, and discolored work shall be restored to original condition or replaced with new work.

3.13 COLD WEATHER CONDITIONS

A. CONSTRUCTION:

During cold weather, that is, when the air temperature is below 40 degrees F and falling, or when it appears that the air temperature will drop to 40 degrees F or below within 24 hours, Contractor shall not lay masonry unless the work is protected from freezing as specified below. Surfaces receiving mortar shall be free of ice and frost. The following requirements shall be adhered to:

1. Air Temperature 40 to 32 Degrees F: Heat sand or mixing water to produce mortar temperature between 40 and 120 degrees F.

2. Air Temperature 32 to 25 Degrees F: Heat sand and mixing water to produce mortar temperature between 40 and 120 degrees F.

3. Air Temperature 25 to 20 Degrees F: Heat sand and mixing water to produce mortar temperature between 40 and 120 degrees F. Use other heat

sources on both sides of walls under construction. Use windbreaks when wind is in excess of 15 mph.

4. Air Temperature 20 Degrees F and Below: Heat sand and mixing water to produce mortar temperature between 40 and 120 degrees F. Provide enclosures and auxiliary heat to maintain air temperature above 32 degrees F on both sides of walls under construction. Ascertain that temperatures of masonry units are not less than 20 degrees F when units are laid.

B. PROTECTION:

Newly laid masonry shall be protected as specified below for the respective mean daily air temperature (MDAT), that is, the average of the daytime high temperature and the forecasted nighttime low temperature.

1. MDAT 40 to 32 degrees F: Protect masonry from rain and snow by covering the top 4 feet with weather-resistive membrane for 24 hours after laying.

2. MDAT 32 to 25 degrees F: Completely cover newly-laid masonry with weather-resistive membrane for 24 hours.

3. MDAT 25 to 20 degrees F: Completely cover newly-laid masonry with insulating blankets and weather-resistive membrane for 24 hours.

4. MDAT 20 degrees F and Below: Maintain temperature of masonry above 32 degrees F for 24 hours by providing enclosures and supplementary heat or other approved means.

3.14 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 09900. If a coating is specified in Section 09900, do not apply the water repellent specified in this section.

END OF SECTION

Navajo Nation
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

CAMERON PUMP STATIONS AND PRESSURE RELIEF VALVES

DIVISION 5

METALS

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SECTION 05100

STRUCTURAL METALS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies structural metals consisting of standard shapes, fasteners, rods and plates that are used in structural supports and connections.

1.02 QUALITY ASSURANCE

A. GENERAL:

Structural assemblies and shop and field welding shall meet the requirements of the AISC Manual of Steel Construction.

The use of salvaged, reprocessed or scrap materials shall not be permitted.

B. REFERENCES:

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.

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
AISC Steel Construction Manual	American Institute of Steel Construction, Steel Construction Manual, 15th Edition

Reference	Title
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
ASTM A307	Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
ASTM A320	Alloy-Steel Bolting Materials for Low-Temperature Service
ASTM A325	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A992	Steel for Structural Shapes for Use in Buildings
AWS-B3.0	Welding Procedures and Performance Qualifications
AWS-Dl.1	Structural Welding Code--Steel

1.03 SUBMITTALS

A. Shop drawings, including erection plans, member and connection details, steel materials, coatings, etc as required to fully delineate this portion of the work.

B. Certification that steel fabricator is approved to perform steel fabrication without special inspection.

C. Evidence that steel fabricator has AISC Certification for Steel Building Fabrication. Certificate to show name and address of certified firm, effective date, and category of certification.

D. Welding procedures, qualifications, and inspection report.

E. Certified mill test reports for structural steel and high-strength bolts and nuts.

F. In accordance with IBC Chapter 17, steel fabricator at the completion of fabrication to submit Certification of Compliance stating that the fabrication was performed in accordance with the design documents.

PART 2--PRODUCTS

2.01 MATERIALS

A. STEEL:

Table A, Steel Materials

Material	Specification
Standard rolled steel wide flange sections (and WTs)	ASTM A992
Structural steel S-shapes, channels, angles and plates	ASTM A36
Pipe sections for posts, guardrails and handrails	ASTM A53, Type E or S, Grade B
Structural steel tubing	ASTM A500, Grade C (Fy = 50 ksi)
Stainless steel bolts (used at stainless steel and aluminum framing unless noted otherwise)	ASTM A193, Grade B8M Class 1, AISI 316 or ASTM A320, Grade B8M Class 1, AISI 316
Stainless steel nuts and washers (used at stainless steel and aluminum framing unless noted otherwise)	ASTM A194 Grade 8M, SS316
Steel bolts (used at galvanized and painted steel framing)	Galvanized ASTM A325 (Type 1), bearing type bolts fully tensioned

2.02 FABRICATION

Steel fabrication shall be in accordance with the AISC Manual of Steel Construction.

PART 3--EXECUTION

3.01 INSTALLATION

A. GENERAL:

Measurements shall be verified at the job.

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 drilled. No drifting of bolts nor enlargement of holes will be allowed to correct misalignment. Mismatched holes shall be corrected with new material.

Dissimilar metals shall be protected 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.

Metalwork to be embedded in concrete shall be as specified in Section 03300. Metalwork shall be placed accurately and held in correct position while the concrete is placed or, if specified, recesses or blockouts shall be formed in the concrete after design strength is attained, and the metalwork shall be grouted in place in accordance with Section 03300. The surfaces of metalwork in contact with or embedded in concrete shall be thoroughly cleaned.

Structural steel completely encased in concrete shall not be galvanized or painted and shall have a clean surface for bonding to concrete. Metalwork which is bent, broken or otherwise damaged shall be repaired or replaced by the CONTRACTOR.

B. WELDING:

Welding shall be performed by operators 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 Code for Arc Welding in Building Construction.

Unless otherwise specified, continuous welds shall be provided on all structural members that are exposed to weather or submerged in water or wastewater, and continuous seal welds shall be provided on both sides of all plates or structural shapes that are in contact with or submerged in water or wastewater.

C. BOLTED CONNECTIONS:

Bolted connections shall conform to AISC Framed Beam Connections and shall be bearing type connections, with bolts fully tensioned unless connecting HSS shapes.

3.02 CORROSION PROTECTION

Unless otherwise specified, carbon steel shall be galvanized. If coatings are indicated in the Drawings or elsewhere in the Specifications, coat in accordance with Section 09900. Coating surface preparation shall be as specified in Section 09900 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.

3.03 CLEANING

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 05910.

END OF SECTION

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SECTION 05311

STEEL ROOF DECK

PART 1 GENERAL

1.01 DESCRIPTION

A. GENERAL:

This section specifies fabrication and erection of steel roof deck.

1.02 QUALITY ASSURANCE

A. QUALITY CONTROL BY OWNER:

The CONTRACTOR will pay for special inspection and testing in accordance with Section 01400.

B. REFERENCES:

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

Reference	Title
Steel Deck Institute (SDI)	Design Manual for Composite Decks, Form Decks, Roof Decks, and Cellular Metal Floor Deck with Electrical Distribution

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

A. 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.

B. Details and gages of all accessories and miscellaneous items showing sump pans, cant strips, ridge and valley plates, closure strips and insulation supports.

C. Manufacturer's ICC Evaluation Report with load tables including design thickness in inches, section properties, allowable gravity load, allowable diaphragm shear loads and allowable construction live loads.

D. Erection marks. Mark each bundle to correspond to the shop drawings.

E. Certification from SDI that manufacturer is a member of SDI and that the steel roof deck is designed in accordance with SDI standards.

F. Certification for installers of deck fastening systems.

1.04 QUALITY ASSURANCE

Steel roof deck shall conform to the requirements of the SDI standard for Steel Roof Deck.

Deck manufacturer shall be a member of the Steel Deck Institute and design of the deck shall be by a qualified professional engineer.

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

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:

ASTM A653, SS, Grade 33, minimum yield 38 ksi, with Designation G60 galvanized coating.

B. STRUCTURAL STEEL:

ASTM A36.

C. GALVANIZING REPAIR PAINT:

Paint shall be 95 percent zinc dust, organic vehicle primer compatible with galvanized surfaces per Section 05910.

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 or approved equal.

B. CLOSURE PLATES:

Fabricate closure plates of galvanized sheet steel of same quality as deck units. Provide tight-fitting closure with deck units.

C. FABRICATION TOLERANCES:

Maximum variation in unit alignment shall be 1/4 inch in 40 feet.

PART 3 EXECUTION

3.01 INSPECTION

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

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.

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.

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.

Suspended ceilings, light fixtures, ducts, piping, conduits, or other utilities shall not be attached to steel roof deck.

3.03 FIELD PAINTING

Touch up galvanized surfaces with galvanizing repair paint applied in accordance with manufacturer’s instructions and Section 05910.

3.04 INSPECTION

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.

Special inspection of the decking is required for the type, depth, gage, and attachment of the decking.

END OF SECTION

SECTION 05501

ANCHORS TO CONCRETE AND MASONRY

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies anchor systems; 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, limited use expansion (wedge type) anchors, nuts and washers. Cast-in-place anchor bolts are specified as hot-dip galvanized or Type 316 stainless steel; all-thread rods are Type 316 stainless steel.

1.02 QUALITY ASSURANCE/QUALITY CONTROL

A. QUALITY ASSURANCE BY OWNER:

Special inspection of anchor bolts shall be performed by the Special Inspector paid for by the Contractor and in accordance with IBC Chapter 17.

B. REFERENCES

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
ACI 318	Building Code Requirements for Structural Concrete
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
ASTM A320	Alloy-Steel Bolting Materials 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

Reference	Title
IBC 2015	International Building Code with local amendments

1.03 SUBMITTALS

Provided the following submittals in accordance with Section 01300:

1. Anchor bolt placement plans.

2. Anchor bolt, nut, and washer material information, including material certifications.

3. Where required here-in or by other sections of the Contract Documents, submit 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. Calculations will not be reviewed by the Engineer and calculations will not be returned to the Contractor

4. 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.
   b. Product data indicating load capacity charts/calculations.
   c. Chemical resistance.
   d. Temperature limitations.
   e. Manufacturers written installation instructions.

PART 2--PRODUCTS

2.01 GENERAL

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 shall be provided as specified in Section 11002.

Tapered washers shall be provided where mating surface is not square with the nut.

When cast-in-place anchors are specifically indicated, post-installed anchors set in holes drilled in the concrete after the concrete is placed will not be permitted unless specifically requested by the Contractor and approved by the Engineer.

2.02 MATERIALS

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 and Washers	ASTM A194 Heavy Hex Nuts and Washers (ASTM F594 Heavy Hex Nuts at Adhesive Anchors), Type 316
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
Concrete Adhesive Anchors	Hilti “HIT-RE 500-V3”, Simpson “SET-XP”, or equal – Type 316 stainless steel
Masonry Adhesive Anchors	Hilti "HIT-HY 270", Simpson “SET-XP”, or equal – Type 316 stainless steel
Masonry Expansion (wedge) Anchors*	Hilti "KWIK BOLT 3", or equal – Type 316 stainless steel
Concrete Expansion (wedge) Anchors *	Hilti “KWIK BOLT TZ2”, or equal, Type 316 stainless steel

*Post installed anchors shall always be an adhesive type anchor system except when Contractor makes a request for a specific application and Engineer approves.

2.03 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.

2.04 ANCHOR BOLT SLEEVES

A. Provide anchor bolt sleeves as required by equipment manufacturer's design for minor location adjustment.

1. High density polyethylene plastic 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.

2.05 DESIGN

Anchor bolts for equipment and support and bracing of nonstructural components shall be designed by the equipment manufacturer to include seismic and wind forces when applicable. Design criteria provided in Section 01900.

PART 3--EXECUTION

3.01 GENERAL

A. Anchor bolts shall be cast- in-place where indicated.

B. Grouting of anchor bolts using plastic sleeves with non-shrink or epoxy grout, where required by equipment manufacturer's design, shall be in accordance with Section 03600.

C. The threaded end of anchor bolts and all-thread rod 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

Anchor bolts to be embedded in concrete shall be placed accurately and held in correct position using templates while the concrete is placed.

After anchor bolts have been embedded, their threads shall be protected by grease and the nuts run on.

3.03 ADHESIVE ANCHOR BOLTS

Note that adhesive anchors shall not be substituted for anchor bolts which are specifically indicated to be cast-in-place. Use of adhesive anchors shall be subject to the following conditions:

1. Limit to locations where exposure, on an intermittent or continuous basis, to acid concentrations higher than 10 percent, to chlorine gas, or to machine or diesel oils, is extremely unlikely.

2. Limit to applications where exposure to fire or exposure to concrete or rod temperature above 120 degrees F is extremely unlikely. Overhead applications (such as pipe supports) shall not be allowed.

3. Approval from Engineer for specific application and from supplier of equipment to be anchored, if applicable.

4. Anchor diameter and material shall be per equipment manufacturer's specifications. Anchor shall be threaded or deformed full length of embedment and shall be free of rust, scale, grease, and oils.

5. Embedment depth shall be as specified by the equipment manufacturer (minimum 6 inches) unless noted otherwise.

6. Follow the anchor system manufacturer's written installation instructions.

7. Holes shall have rough surfaces created by using a hammer drill with carbide bit (core drilled holes are not allowed).

8. Holes shall be blown clean with oil-free compressed air and be free of dust or standing water prior to installation.

9. Concrete and air temperature shall be compatible with curing requirements of adhesives per adhesive manufacturer instructions. Anchors shall not be placed in when concrete temperature is below 25 degrees F.

10. Anchors shall be left undisturbed and unloaded for full adhesive curing period which is based on temperature of the concrete.

3.04 EXPANSION ANCHORS

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 3 through 8 as specified above for adhesive anchors. Expansion anchors shall not be used in a submerged condition nor 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 Project Representative and resolve the conflict to the satisfaction of the Project 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 for record purpose.

END OF SECTION

SECTION 05505

MISCELLANEOUS METALWORK

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies fabricated metalwork items and other miscellaneous metalwork.

1.02 QUALITY ASSURANCE

A. GENERAL:

The use of salvaged, reprocessed or scrap materials will not be permitted.

B. REFERENCES:

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.

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 A14.3	Standard for Ladders - Fixed - Safety Requirements
AISC 303-10	Code of Standard Practice for Steel Buildings and Bridges
AISC 360-10	Specification for Structural Steel Buildings
AISC Manual	American Institute of Steel Construction, Manual of Steel Construction, Thirteenth Edition
Aluminum Design Manual	The Aluminum Association, Aluminum Design Manual with Specifications and Guidelines
ASTM A36	Specification for Carbon Structural Steel

Reference	Title
ASTM A48	Specification for Gray-Iron Castings
ASTM A53	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality
ASTM A123	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip
ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials 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
ASTM A240	Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
ASTM A276	Specification for Stainless Steel Bars and Shapes
ASTM A283	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
ASTM A307	Standard Specification for Carbon Steel Externally Threaded Standard Fasteners
ASTM A312	Standard Specification for Seamless and Welded Austenitic Stainless steel Pipes
ASTM A320	Standard Specification for Alloy-Steel Bolting Materials for Low Temperature Service
ASTM A325	Specification for 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

Reference	Title
ASTM A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A563	Specification for Carbon and Alloy Steel Nuts
ASTM A653	Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780	Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A786	Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
ASTM A793	Specification for Rolled Floor Plate, Stainless Steel
ASTM A924	Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A967	Specification for Chemical Passivation Treatments for Stainless Steel Parts
ASTM A992	Standard Specification for Structural Steel Shapes
ASTM B209	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B210	Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes
ASTM B211	Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire
ASTM B221	Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B241	Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
ASTM B308	Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM B632	Standard Specification for Aluminum-Alloy Rolled Tread Plate
ASTM B695	Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM D1056	Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM F436	Specification for Hardened Steel Washers

Reference	Title
ASTM F468	Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use
ASTM F593	Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Specification for Stainless Steel Nuts
ASTM F844	Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F1554	Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ICC	International Code Council Evaluation Reports for Concrete and Masonry Anchors
NSF	NSF International
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 1926.105	Safety Nets
OSHA 29 CFR 1926.502	Fall Protection Systems Criteria and Practices
RCSC	Design Specification for Structural Joints using ASTM A325 or A490 Bolts
IBC	2015 International Building Code

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

1. Procedures: Section 01300.

2. Manufacturer's product data showing conformance to the specification.

3. Detailed Shop Drawings: Submit fabrication drawings showing layouts, connections to structural system, and anchoring details. Submit erection and installation drawings indicating thickness, type, grade, class of metal, coating system and dimensions. Show construction details, reinforcement, anchorage, and installation with relation to the building construction.

4. Welding procedures and welder certificates and qualifications for the work being performed.

5. Passivation method for stainless steel fabrications.

PART 2--PRODUCTS

2.01 MATERIALS

Materials for miscellaneous metalwork are specified in Table A.

Table A, Materials for Miscellaneous Metalwork

Material	Specification
Carbon Steel	
Sheets, plates and shapes (except W shapes)	ASTM A36
Steel W shapes	ASTM A992
Pipe	ASTM A53, Grade B
Square/rectangular tubing	ASTM A500, Grade B
Headed Anchor Studs	ASTM A108
Deformed anchor bars	ASTM A496
Carbon steel bolts	ASTM A307, Grade A
High strength bolts	ASTM A325 (Type 1)
Nuts	ASTM A563
Washers	ASTM F844
Stainless Steel	
Sheets 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 A193 or A320, Type 316
Bolts	ASTM A193, Grade B8M Class 1, AISI 316 or ASTM A320, Grade B8M Class 1, AISI 316
Nuts	ASTM A194 Grade 8M, SS316

Material	Specification
Thrust Ties for Steel Pipe	
Threaded rods	ASTM A193/A193M, Grade B7
Nuts	ASTM A194/A194M, Grade 2H
Plate	ASTM A283/A283M, Grade D
Other steel items	
Iron castings	ASTM A48
Eyebolts	ASTM A489
Threaded rods	ASTM A36/A36M

2.02 FABRICATION

A. GENERAL:

Conform to AISC or Aluminum Association standards as applicable. Where Code defined loads apply, also conform to IBC requirements.

Shop and field welding shall conform to the requirements of the AISC Manual of Steel Construction, the Aluminum Association Design Manual, and applicable AWS procedures and specifications as required by the material being welded

Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt, tight, flush, and hairline. Remove all burrs and weld splatter. Ease exposed edges to small uniform radius.

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.

Fabrication including cutting, drilling, punching, threading and tapping required for miscellaneous metal or adjacent work shall be performed prior to hot-dip galvanizing.

F. PIPE SLEEVES

Unless otherwise indicated on design drawings, fabricate pipe sleeves from schedule 40 steel pipe with 3/16” thick by 3’ wide seep ring continuously seal welded to the outside of the pipe. Galvanize after fabrication in accordance with ASTM A123.

G. FIXED BOLLARDS

Provide 6 inch galvanized standard weight steel pipe or as indicated on the design drawings. Pipe to be in accordance with ASTM A53. Anchor posts in concrete as indicated and fill solidly with concrete with minimum compressive strength of 2500 psi.

H. OTHER MISCELLANEOUS STEEL METALWORK:

Other miscellaneous steel metalwork including embedded and non-embedded steel metalwork, hangers and inserts shall be as specified on the drawings and shall be hot-dip galvanized after fabrication unless otherwise note on the design drawing.

2.03 FABRICATION FINISHES

A. GALVANIZING

For the galvanizing of miscellaneous metal work reference specification 05910.

B. SHOP PAINTING

Surface prepare by blast clean surfaces in accordance with the project coating specification. Steel to be embedded in concrete shall be free of dirt and grease. Do not paint or galvanize bearing surfaces, including contact surfaces within slip critical joints, but coat with rust preventative applied in the shop. On surfaces concealed in the finished construction or not accessible for finish painting, apply an additional prime coat.

C. ALUMINUM SURFACES

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. Aluminum finishes for unexposed sheet, plate and extrusions may have mill finish as fabricated. Provide all other aluminum items with a standard mill finish. Provide a coating thickness not less than that specified for protection. Provide decorative type finishes for items used in interior occupied locations or architectural type finish for items used in exterior locations. Provide a polished satin finish on items to be anodized.

D. STAINLESS STEEL PASSIVATION

Stainless steel to be cleaned, descaled, and passivated after fabrication in accordance with ASTM A380. Passivation to removal iron compounds from the surface of the stainless steel.

PART 3--EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Verify measurements at the site. Include field dimensions in shop drawings.

B. Verify that field conditions are acceptable and are ready to receive work.

C. Make provisions for erection loads with temporary bracing. Keep work in alignment.

D. Supply items required to be cast into concrete or embedded in masonry with setting templates.

3.02 INSTALLATION OF METAL FABRICATIONS

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. If accepted, recesses may be neatly cored in the concrete after it has attained its design strength and the metalwork grouted in place.

G Pipe Sleeves:

1. Provide where pipes pass through concrete or masonry.

2. Holes drilled with a rotary drill may be provided in lieu of sleeves in existing walls.

3. Provide a center flange for water stoppage on sleeves in exterior or water-bearing walls

4. Provide a rubber caulking sealant or a modular mechanical unit to form a watertight seal in the annular space between pipes and sleeves

3.03 FIELD REPAIR OF COATINGS

A. Galvanized:

1. Maximum area to be repaired shall be no 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, Paragraph 6.2.3.

3. Use zinc-rich repair paint.

4. Acceptable manufacturer:

a. ZRC Galvilite.

b. LPS Cold Galvanize

c. Approved equal.

B. Painted: after installation, clean and touch up damaged areas with the same materials used for the shop coat.

3.04 ELECTROLYTIC PROTECTION

A. Coat surfaces of aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09900, unless indicated otherwise.

3.05 STAINLESS STEEL

A. During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.

B. After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.

C. Remove contamination in accordance with requirements of ASTM A380.

D. Brushes used to remove foreign substances shall utilize only stainless steel or nonmetallic bristles.

3.06 FASTENER SCHEDULE

A. Provide fasteners as follows:

Service Use and Location	Product	Remarks
1. Connections for Carbon Steel Fabrications		
Interior and exterior areas	Galvanized high-strength bolts	Applies to both galvanized and painted carbon steel fabrications
2. Connections of Aluminum Components		
All areas	Stainless steel fasteners	
3. All Others		
Exterior and interior areas	Stainless steel fasteners	

END OF SECTION

SECTION 05910

HOT-DIP GALVANIZING

PART 1 GENERAL

1.01 DESCRIPTION

A. Section includes: Hot-dip galvanizing of steel materials.

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 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

1.03 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.

1.04 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 ASTM A153, 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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Navajo Nation
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

CAMERON PUMP STATIONS AND PRESSURE RELIEF VALVES

DIVISION 6

WOOD AND PLASTICS

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SECTION 06100

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: For each type of process and factory-fabricated product.

1.03 INFORMATIONAL SUBMITTALS

A. Material Certificates: 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.

B. Evaluation Reports: For the following, from ICC-ES:

1. Wood-preservative-treated wood.

PART 2 - PRODUCTS

2.01 WOOD PRODUCTS, GENERAL

A. Lumber: 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. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.02 WOOD-PRESERVATIVE-TREATED LUMBER

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 MISCELLANEOUS LUMBER

A. General: 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. Mixed southern pine or southern pine; No. 2 grade; SPIB.

2. Eastern softwoods; No. 2 Common grade; NeLMA.

3. Northern species; No. 2 Common grade; NLGA.

4. Western woods; Construction or No. 2 Common grade; WCLIB or WWPA.

2.04 FASTENERS

A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture.

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 A 153/A 153M.

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.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Set rough carpentry 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. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

D. Do not splice structural members between supports unless otherwise indicated.

E. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

F. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

G. 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 enough that moisture content exceeds that specified, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

SECTION 06160

SHEATHING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Composite nail base insulated roof sheathing and roof insulation.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product.

PART 2 - PRODUCTS

2.01 COMPOSITE NAIL BASE INSULATED ROOF SHEATHING

A. Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing: ASTM C 1289, Type V with DOC PS 2, Exposure 1 oriented strand board on one face.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Atlas Roofing Corporation; AC Foam Nail Base Insulation or a comparable product by one of the following:

a. Dow Chemical Company (The).

b. Johns Manville; a Berkshire Hathaway company.

2. Polyisocyanurate-Foam Thickness: 4 inches.

3. Oriented-Strand-Board Nominal Thickness: 7/16 inch.

2.02 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 A 153/A 153M.

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 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.

2. 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.

END OF SECTION

Navajo Nation
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

CAMERON PUMP STATIONS AND PRESSURE RELIEF VALVES

DIVISION 7

THERMAL AND MOISTURE PROTECTION

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SECTION 07190

WATER REPELLENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes penetrating water-repellent treatments for the following vertical and horizontal surfaces:

1. Concrete unit masonry.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of water repellent and substrate indicated.

1.03 INFORMATIONAL SUBMITTALS

A. Product certificates.

1.04 QUALITY ASSURANCE

A. Applicator Qualifications: An employer of workers trained and approved by manufacturer.

PART 2 - PRODUCTS

2.01 PENETRATING WATER REPELLENTS

A. RTV Silicone Rubber Penetrating Water Repellent: Clear, solvent-based silicone elastomer.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Prosoco, Inc.: Sure Klean Weather Seal Blok Guard & Graffiti Control.

b. Professional Products of Kansas: PWS-15.

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 07410

STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes standing-seam metal roof panels.

B. Soffit panels.

C. Snow guards.

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. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:

1. Wind Loads: 30 psf.

2. Other Design Loads: As indicated on Drawings.

3. Deflection Limits: For wind loads, no greater than 1/240 of the span.

B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E 1680 or ASTM E 283 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 E 1646 or ASTM E 331 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft.

D. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E 2140.

E. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: UL 90.

F. 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. General: 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 E 1514.

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; Zee-Lock or a comparable product by one of the following:

a. AEP Span; A BlueScope Steel Company.

b. ATAS International, Inc.

c. CENTRIA Architectural Systems.

d. Englert, Inc.

e. Fabral.

f. Firestone Metal Products, LLC.

g. IMETCO.

h. Petersen Aluminum Corporation.

2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

a. Nominal Thickness: 24 gauge.

b. Exterior Finish: Two-coat fluoropolymer.

c. Color: As selected by Architect from manufacturer's full range.

3. Clips: Two-piece floating to accommodate thermal movement.

a. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.

4. Joint Type: Single folded.

5. Panel Coverage: 16 inches.

6. Panel Height: 2.0 inches.

2.03 SOFFIT PANELS

A. Metal Soffit Panels: Formed standard with two grooves and interlocking side lap; designed for sequential installation by mechanically attaching panels to supports using concealed fasteners.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Berridge Manufacturing Company; L-Panel or a comparable product by one of the following:

    a. AEP Span; A BlueScope Steel Company.

    b. ATAS International, Inc.

    c. CENTRIA Architectural Systems.

    d. Englert, Inc.

    e. Fabral.

    f. Firestone Metal Products, LLC.

    g. IMETCO.

    h. Petersen Aluminum Corporation.

2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

    a. Nominal Thickness: 24 gauge.

    b. Exterior Finish: Two-coat fluoropolymer.

    c. Color: As selected by Architect from manufacturer's full range.

3. Panel Coverage: 11-5/8 inches.

4. Panel Height: 1.0 inches.

2.04 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 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 D 1970.

2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D 1970.

3. 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. Carlisle Residential; a division of Carlisle Construction Materials.

   b. Grace Construction Products; W.R. Grace & Co. -- Conn.

   c. Henry Company.

B. Felt Underlayment: ASTM D 226/D 22M, Type II (No. 30), asphalt-saturated organic felts.

C. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.05 MISCELLANEOUS MATERIALS

A. 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.

B. Panel Fasteners: Self-tapping screws designed to withstand design loads.

C. 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 C 920; as recommended in writing by metal panel manufacturer.

3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.06 FABRICATION

A. General: 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.

2.07 FINISHES

A. Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat.

2. Concealed Finish: White or light-colored acrylic or polyester backer finish.

2.08 SNOW GUARD

A. Snow Guard System: S-5! ColorGard system manufactured by Metal Roof Innovation approved equal. System to include extrusions, prefinished metal strips matching roof panels, splice connectors for crossmember sections, fasteners, and all related items necessary for a complete installation.

1. Crossmember is to be continuous and include splice connectors to join adjacent sections, ensuring alignment and structural continuity. Attach crossmember to clamps using minimum 3/8” diameter stainless steel bolts with flat washers.

2. Provide S-5-U clamps manufactured by Metal Roof Innovation complete with stainless steel set screws and stainless steel bolt and washer as furnished by the

manufacturer to attach the system to the standing seam roof. Clamp spacing as calculated and not exceeding 32” o.c.

3. Between each rib provide SnoClip as required to prevent snow from sliding underneath snow guard.

PART 3 - EXECUTION

3.01 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.02 UNDERLAYMENT INSTALLATION

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. Felt Underlayment: Apply at locations indicated below, in shingle fashion to shed water, and with lapped joints of not less than 2 inches.

1. Apply over the entire roof surface.

C. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels.

D. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 07620 "Sheet Metal Flashing and Trim."

3.03 METAL PANEL INSTALLATION

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 SNOW GUARD INSTALLATION

A. Verify that panel seam area is reasonably clean and free of visible dirt and foreign matter at the clamp locations prior to installing clamps. Verify that any required machine seaming is complete prior to installation and that panels are adequately attached and supported to the building structure to resist any loads imposed on the clamps.

B. Install system to comply with design calculations and in accordance with manufacturer’s instructions. Carefully lay out desired assembly locations true-to-line prior to installing clamps. Clamps should avoid panel attachment clips if the clip is a single piece design. Assemble set screws to clamp and clamp to seam following all manufacturers printed instructions. Both set screws are to be at the same side of clamp. Verify manufacturer’s minimum recommended setscrew tension using calibrated torque wrench per manufacturer’s instructions. Install snow retention assemblies straight and true-to-line. Secure all material per manufacturer’s instructions. Join adjacent sections with splice pieces provided. Do not cantilever cross member more than 6” past the last lamp in an assembly.

C. Install SnoClips per manufacturer’s recommendations.

3.05 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

SECTION 07620

SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Formed roof-drainage sheet metal fabrications.

2. Formed steep-slope roof sheet metal fabrications.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For sheet metal flashing and trim.

1. Include plans, elevations, sections, and attachment details.

2. Distinguish between shop- and field-assembled work.

3. Include identification of finish for each item.

4. Include pattern of seams and details of termination points, expansion joints and expansion-joint covers, direction of expansion, roof-penetration flashing, and connections to adjoining work.

C. Samples: For each exposed product and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Product test reports.

C. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 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.

1.7 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. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim assemblies shall 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 shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" and 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.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METALS

A. General: 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 according to ASTM A 653/A 653M, G90 coating designation or aluminum-zinc alloy-coated steel sheet according to ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40; prepainted by coil-coating process to comply with ASTM A 755/A 755M.

1. Surface: Manufacturer's standard clear acrylic coating on both sides.

2. Exposed Coil-Coated Finish:

a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent 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.

2.3 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, 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 Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

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 C 920, elastomeric polyurethane 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 C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

F. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

G. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.

H. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.4 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.

1. Obtain field measurements for accurate fit before shop fabrication.

2. 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.

3. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. 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.

C. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.

D. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

E. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.

F. Seams: 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.

2.5 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters: Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch-long sections. Furnish flat-stock gutter brackets and 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. Fabricate expansion joints, expansion-joint covers, and gutter accessories from same metal as gutters.

B. Downspouts: Fabricate rectangular downspouts to dimensions indicated, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors.

1. Fabricate from one of the following materials:

a. Galvanized Steel: 24 gauge.

b. Aluminum-Zinc Alloy-Coated Steel: 24 gauge.

2.6 STEEP-SLOPE ROOF SHEET METAL FABRICATIONS

A. Drip Edges: Fabricate from one of the following materials:

1. Galvanized Steel: 24 gauge.

2. Aluminum-Zinc Alloy-Coated Steel: 24 gauge.

B. Eave, Rake Flashing: Fabricate from one of the following materials:

1. Galvanized Steel: 24 gauge.

2. Aluminum-Zinc Alloy-Coated Steel: 24 gauge.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.

1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.

2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

3. Space cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.

4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.

5. Torch cutting of sheet metal flashing and trim is not permitted.

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. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.

2. 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. Prepare joints and apply sealants to comply with requirements in Section 07920 "Joint Sealants."

G. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

3.2 ROOF-DRAINAGE SYSTEM INSTALLATION

A. General: Install sheet metal roof-drainage items to produce complete roof-drainage system according to cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

B. Hanging Gutters: Join sections with joints sealed with sealant. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchor them in position. Provide end closures and seal watertight with sealant. Slope to downspouts.

1. Install gutter with expansion joints at locations indicated, but not exceeding, 50 feet apart. Install expansion-joint caps.

C. Downspouts: Join sections with 1-1/2-inch telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches o.c.

3.3 ROOF FLASHING INSTALLATION

A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate.

C. 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.

D. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints minimum of 4 inches.

E. 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.

3.4 CLEANING AND PROTECTION

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.

D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

END OF SECTION

SECTION 07920

JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Urethane joint sealants.

2. Latex joint sealants.

1.02 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

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.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

A. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

B. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

2.02 URETHANE JOINT SEALANTS

A. Urethane Joint Sealant: ASTM C 920.

1. Basis-of-Design Product: Subject to compliance with requirements, provide 2C-SL and 2C-NS by Sika Corporation or comparable product by one of the following:

   a. BASF Building Systems.

   b. Pecora Corporation.

   c. Tremco Incorporated.

2. Type: Multicomponent (M).

3. Grade: Pourable (P) or nonsag (NS).

4. Class: 50.

2.03 LATEX JOINT SEALANTS

A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

1. Basis-of-Design Product: Subject to compliance with requirements, provide AC-20 by Pecora or comparable product by one of the following:

   a. BASF Building Systems.

   b. Tremco Incorporated.

2.04 JOINT SEALANT BACKING

A. Cylindrical Sealant Backings: ASTM C 1330, 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.

2.05 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.

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 of joint sealants.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.02 INSTALLATION

A. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

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.

1. Do not leave gaps between ends of sealant backings.

2. Do not stretch, twist, puncture, or tear sealant backings.

3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

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 according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.

2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.

F. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

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.

2. Joint Sealant: Urethane.

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. Construction joints in cast-in-place concrete.

    b. Control and expansion joints in unit masonry.

    c. Joints between metal panels.

    d. Joints between different materials listed above.

    e. Perimeter joints between materials listed above and frames of doors and louvers.

    f. Control and expansion joints in ceilings and other overhead surfaces.

2. Joint Sealant: Urethane.

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.

2. Joint Sealant: Urethane.

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. Perimeter joints of exterior openings where indicated.

   c. Perimeter joints between interior wall surfaces and frames of interior doors and windows.

2. Joint Sealant: Latex.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION

Navajo Nation
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

CAMERON PUMP STATIONS AND PRESSURE RELIEF VALVES

DIVISION 8

DOORS AND WINDOWS

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SECTION 08110

HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes hollow-metal work.

1.02 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include elevations, door edge details, frame profiles, metal thicknesses, preparations for hardware, and other details.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of exposed finish required.

E. Schedule: Prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings.

1.04 INFORMATIONAL SUBMITTALS

A. Product test reports.

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. Amweld International, LLC.

2. Ceco Door; ASSA ABLOY.

3. Commercial Door & Hardware Inc.

4. Curries Company; ASSA ABLOY.

5. Rocky Mountain Metals, Inc.

6. Steelcraft; an Ingersoll-Rand brand.

7. Stiles Custom Metal, Inc.

8. West Central Mfg. Inc.

2.02 EXTERIOR HOLLOW-METAL DOORS AND FRAMES

A. Maximum-Duty Doors and Frames: SDI A250.8, Level 4.

1. Physical Performance: Level A according to SDI A250.4.

2. Doors:

a. Type: As indicated in the Door and Frame Schedule.

b. Thickness: 1-3/4 inches.

c. Face: Metallic-coated steel sheet, minimum 14 gauge, with minimum A40 coating.

d. Edge Construction: Model 2, Seamless.

e. Core: Manufacturer's standard insulation material.

3. Thermal-Rated Doors: Provide doors fabricated with thermal-resistance value (R-value) of not less than 10.0 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.

4. Frames:

a. Materials: Metallic-coated steel sheet, minimum 14 gauge, with minimum A40 coating.

b. Construction: Full profile welded.

5. Exposed Finish: Prime.

2.03 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.

2. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch-diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2.04 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

D. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Power-Actuated Fasteners in Concrete: From corrosion-resistant materials.

G. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.

H. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing).

I. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat.

2.05 FABRICATION

A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Hollow-Metal Doors:

1. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.

2. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated.

C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. 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 butt welding.

2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.

4. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.

5. Jamb Anchors: Provide number and spacing of anchors as follows:

a. Masonry Type: Locate anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 inches o.c., to match coursing, and as follows:

1) Two anchors per jamb up to 60 inches high.

2) Three anchors per jamb from 60 to 90 inches high.

3) Four anchors per jamb from 90 to 120 inches high.

4) Four anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.

b. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.

D. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to 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 applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

2.06 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: SDI A250.10.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Hollow-Metal Frames: Install hollow-metal frames for doors of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

a. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.

b. Install frames with removable stops located on secure side of opening.

c. Install door silencers in frames before grouting.

d. Remove temporary braces necessary for installation only after frames have been properly set and secured.

e. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

f. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and 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. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.

4. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

5. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb 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 hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Steel Doors:

a. Between Door and Frame Jambs and Head: 1/8 inch plus or minus 1/32 inch.

b. Between Edges of Pairs of Doors: 1/8 inch to 1/4 inch plus or minus 1/32 inch.

c. At Bottom of Door: 5/8 inch plus or minus 1/32 inch.

d. Between Door Face and Stop: 1/16 inch to 1/8 inch plus or minus 1/32 inch.

3.02 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow-metal work immediately after installation.

C. 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.

D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

E. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION

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SECTION 08710

DOOR HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Mechanical door hardware for the following:

a. Swinging doors.

B. Products furnished, but not installed, under this Section include the products listed below. Coordinating and scheduling the purchase and delivery of these products remain requirements of this Section.

1. Permanent lock cores to be installed by Owner.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For each exposed product and for each color and texture specified.

C. Other Action Submittals:

1. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

a. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.

b. Content: Include the following information:

1) Identification number, location, hand, fire rating, size, and material of each door and frame.
2) Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
3) Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.

4) Description of electrified door hardware sequences of operation and interfaces with other building control systems.

2. Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for locks.

1.03 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.

B. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as follows:

1. For door hardware, an Architectural Hardware Consultant (AHC).

C. Source Limitations: Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

D. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

B. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion, unless otherwise indicated.

    a. Manual Closers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SCHEDULED DOOR HARDWARE

A. Provide door hardware for each door as scheduled in Part 3 "Door Hardware Schedule" Article to comply with requirements in this Section.

1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products equivalent in function and comparable in quality to named products.

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. Products are identified by using door hardware designations, as follows:

1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Schedule" Article.
2. References to BHMA Designations: Provide products complying with these designations and requirements for description, quality, and function.

2.02 HINGES

A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.

2.03 MECHANICAL LOCKS AND LATCHES

A. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.

B. Mortise Locks: BHMA A156.13; Security Grade 1; stamped steel case with steel or brass parts; Series 1000.

2.04 MANUAL FLUSH BOLTS

A. Manual Flush Bolts: BHMA A156.16; minimum 3/4-inch throw; designed for mortising into door edge.

2.05 LOCK CYLINDERS

A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.

1. Manufacturer: Same manufacturer as for locking devices.

B. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.

C. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.06 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference.

1. No Master Key System: Only change keys operate cylinder.

B. Keys: Brass.

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

a. Notation: "DO NOT DUPLICATE."

2. Quantity: In addition to one extra key blank for each lock, provide the following:

a. Cylinder Change Keys: Three.

2.07 SURFACE CLOSERS

A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

2.08 MECHANICAL STOPS AND HOLDERS

A. Wall- and Floor-Mounted Stops: BHMA A156.16; polished cast brass, bronze, or aluminum base metal.

2.09 DOOR GASKETING

A. Door Gasketing: BHMA A156.22; air leakage not to exceed 0.50 cfm per foot of crack length for gasketing other than for smoke control, as tested according to ASTM E 283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

2.010 THRESHOLDS

A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

2.011 METAL PROTECTIVE TRIM UNITS

A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch-thick stainless steel; with manufacturer's standard machine or self-tapping screw fasteners.

2.012 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
2. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
3. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.013 FINISHES

A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

B. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.

C. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

D. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

E. Lock Cylinders: Install construction cores to secure building and areas during construction period.

1. Replace construction cores with permanent cores as directed by Owner.
2. Furnish permanent cores to Owner for installation.

F. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 07920 "Joint Sealants."

G. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

H. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

I. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

J. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

K. Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.02 FIELD QUALITY CONTROL

A. Independent Architectural Hardware Consultant: Owner will engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

3.03 DOOR HARDWARE SCHEDULE

KEY:

B	Best	L	LCN	S	Stanley
P	Pemko	T	Trimco		

QTY.	ITEM	NUMBER	MFR.
Group 1 Double ext HM, entry			
3 pair	Hinges	FBB179, 4 ½ x 4 ½, 626, NRP	S
1	Closer	4041H, Cush	L
1	Lockset	45H-7-AB-14H-626	B
2	Flush bolts	3917 x 12” @ Sill, extended rod @ Head	T
1	Strike	3911	T
1	Threshold	272A x Door Width	P
2	Kickplates	KOO50 10”H x Door Width less 2”	T
1	Weatherstripping	305CS, head and jamb	P
1	Sweep	315CN	P

END OF SECTION

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Navajo Nation
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

CAMERON PUMP STATIONS AND PRESSURE RELIEF VALVES

DIVISION 9

FINISHES

09900 Coating Systems

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SECTION 09900

TABLE OF CONTENTS

SECTION 09900

COATING SYSTEMS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This Section 09900 specifies coating systems, surface preparations, and application requirements for coating systems.

B. DEFINITIONS:

Specific coating terminology used in this Section 09900 is in accordance with definitions contained in ASTM D16, ASTM D3960, and the following 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 09900.

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 09900, 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:

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.

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

Reference	Title
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
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

Reference	Title
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

Reference	Title
SSPC-TR2	Wet Abrasive Blast Cleaning
SSPC-TU-3	Overcoating
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:

Materials and supplies provided shall be the standard products of CSMs. Materials in each coating system shall be the products of a single CSM.

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 09900 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.

1. The proposed coating system shall use an equal or greater number of separate coats to achieve the required total dry film thickness.

2. The proposed coating system shall use coatings of the same generic type as that specified including curing agent type.

3. Requests for consideration of products from CSMs other than those specified in this Section 09900 shall include information listed in paragraph 09900-1.04, Items 1, 2, and 3, demonstrating that the proposed CSM's product is equal to the specified coating system.

4. 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 09900; 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 09900. 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 09900.

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 09900-A, included in Section 01999, 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

The Contractor shall conduct inspections at Hold Points during the coating system installation and record the results from those inspections on Form 09900-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:

1. 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.

2. 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.

3. 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.

4. 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 09900 and in the CSM's written instructions.

5. 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.

6. 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.

7. 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 09900 and/or in the CSM's written instructions.

8. 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

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.

Labels on material containers shall show the following information:

1. Name or title of product.
2. CSM's batch number.
3. CSM's name.
4. Generic type of material.
5. Application and mixing instructions.
6. Hazardous material identification label.
7. Shelf life expiration date.

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.

Containers shall be clearly marked indicating personnel safety hazards associated with the use of or exposure to the materials.

Material Safety Data Sheets (MSDS) for each material shall be provided to the Construction Manager.

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:

Provide in accordance with Section 01300:

1. 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.

2. CSM's current printed recommendations and product data sheets for coating systems including:

    a. Volatile organic compound (VOC) data
    b. Surface preparation recommendations.
    c. Primer type, where required.
    d. Maximum dry and wet-mil thickness per coat.
    e. Minimum and maximum curing time between coats, including atmospheric conditions for each.
    f. Curing time before submergence in liquid.
    g. Thinner to be used with each coating.
    h. Ventilation requirements.
    i. Minimum atmospheric conditions during which the paint shall be applied.
    j. Allowable application methods.
    k. Maximum allowable moisture content.
    l. Maximum shelf life.

3. 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.

4. Material Safety Data Sheets (MSDS) for materials to be delivered to the job site, including coating system materials, solvents, and abrasive blast media.

5. List of cleaning and thinner solutions allowed by the CSMs.

6. Storage requirements including temperature, humidity, and ventilation for Coating System Materials as recommended by the CSMs.

7. 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.

8. 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

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 09900 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 B. for further details on these CTR requirements. This inspection is in addition to the inspection performed by the Contractor in accordance with this Section 09900.

A. 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.

B. COATING SYSTEM INSPECTION

While on site to routinely inspect and verify, the CTR shall perform the following activities to confirm acceptability and conformance with the specifications:

1. Inspect ambient conditions during various coating system installation at hold points for conformance with the specified requirements.

2 Inspect the surface preparation of the substrates where the coating system will terminate or will be applied for conformance to the specified application criteria.

3. Inspect preparation and application of coating detail treatment (for example, terminations at joints, metal embedments in concrete, etc.).

4. Inspect application of the filler/surface materials for concrete and masonry substrates.

5. Inspect application of the primers and finish coats including wet and dry film thickness of the coatings.

6. Inspect coating systems for cure.

7. Review adhesion testing of the cured coating systems for conformance to specified criteria.

8. Review coating system continuity testing for conformance to specified criteria.

9. Inspect and record representative localized repairs made to discontinuities identified via continuity testing.

10. Conduct a final review of completed coating system installation for conformance to the specifications.

11. 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.

C. FINAL REPORT

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 09900-2.02. 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 09900 and the CSM's recommendations.

PART 2--PRODUCTS

2.01 MATERIALS

Notwithstanding the listing of product names in this Section 09900, 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.

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.

All of U.S. Except California

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		Macropoxy 646
		B67-600		B67-600
	Tnemec	Series V27 or 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
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
Latex Acrylic				
L-1	PPG PMC	Amercoat 148		Amercoat 220
	Carboline	Carbocrylic 120		Carbocrylic 3359
	International Paint/ICI	UH Gripper 3210		Dulux Pro 1406

All of U.S. Except California

Coating System	CSM	First Coat(s)	Finish Coat(s)
	Sherwin Williams Tnemec	Loxon Acrylic Primer Series 1028 or 1029	Sher Cryl HPA Series 1028 or 1029
S-3	Tnemec or approved equal	N/A	Series V626 Dur A Pell GS or approved equal

***See CSM's Product Data Sheets for acceptable thinners for VOC compliance or do not thin.**

2.02 PRODUCT DATA

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 09900-1.05 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 09900-1.02 C.10 and 09900-1.05 B.12 when the work is underway.

3. Submit the Coating System Inspection Checklists, using Form 09900-A, included in Section 01999, for the coating work.

4. CTR final report in accordance with paragraph 09900-1.05 C.

PART 3--EXECUTION

3.01 COATINGS

A. GENERAL:

Coating products shall not be used until the Construction Manager has accepted the affidavits specified in paragraph 09900-1.04 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.

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 09900-3.01B.3. Damaged, deteriorated and poorly applied shop coatings that do not meet the requirements of this Section 09900 shall be removed and the surfaces recoated. If the shop primer coat meets the requirements of this Section 09900, 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.

D. Erect and maintain protective enclosures as stipulated per SSPC-Guide 6 Guide for Containing Debris Generated During Paint Removal Operations.

3.02 PREPARATION

A. GENERAL:

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.

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.

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.

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:

When abrasive blast cleaning is required to achieve the specified surface preparation the following requirements for blast cleaning materials and equipment shall be met:

1. Used or spent blast abrasive shall not be reused on this project.

2. 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.

3. 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 in item 2 above.

4. Regulators, gauges, filters, and separators shall be in use on compressor air lines to blasting nozzles times during this work.

5. 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.

6. 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.

7. 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.

8. 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.

9. 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:

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.

Clean white cloths and clean fluids shall be used in solvent cleaning.

D. METALLIC SURFACES:

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 09900. 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.

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.

Blast cleaning requirements for steel, ductile iron and stainless steel substrates are as follows:

1. 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.

2. 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.

3. 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.

4. 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.

5. 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.

        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.

    b. 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 07100, 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:

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.

H. EXISTING FACILITIES:

Existing equipment and metalwork shall be coated in accordance with the appropriate coating system specified for new work in paragraph 3.05 COATSPEC.

Modified work shall require the full coating system. Other work shall require cleaning and surface preparation as recommended by the CSM followed by two finish coats of the appropriate system.

Contractor shall demonstrate that the existing coating is compatible with field coating by performing the adhesion test specified in paragraph 09900 – 3.01 B.3. Where unacceptable test results are obtained, the Contractor shall follow manufacturer's written instructions as to the necessity of a tie coat to provide a satisfactory bond between the existing coating and the specified field coating. The difference in cost between the specified coatings and that which is compatible with existing coatings, or work required to remove exiting coatings, will be paid for as extra work unless identified in the Scope of Work for the project already."

Abrasive blasting shall be used to clean wall surfaces of existing process channels and tanks to be coated. Surfaces to be coated, or recoated, shall be repaired, cleaned, and finished to the standards as specified herein.

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:

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:

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.

   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.

2. Perform application detail work per CSM's current written recommendations and/or drawings.

E. PROTECTION OF COATED SURFACES:

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 16 and 17 shall be coated as specified in paragraph 09900-3.03 I.

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:

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:

Electrical and instrumentation equipment and materials shall be coated by the equipment manufacturer as specified below.

1. 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.

   Unless otherwise specified, instrumentation panels shall be coated with system E-1 for indoor mounting and system EU-1 for outdoor mounting.

   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.

2. 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.

   Exterior color of instrumentation panels and cabinets mounted indoors shall be FS 26463 light gray; unless otherwise specified, exterior color for cabinets mounted outdoors shall be FS 27722, white. Cabinet interiors shall be FS 27880, white.

J. SOLUBLE SALT CONTAMINATION OF METALLIC SUBSTRATES:

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

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)

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 09900-3.06, Coating System Schedule. In case of conflict between the schedule and the COATSPECS, the requirements of the schedule shall prevail.

Coating Specification Sheets included in Table 09900A are included this paragraph 09900-3.05.

Table 09900A 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-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.
L-1	Latex	Concrete, masonry, plaster, gypsum board	Interior and Exterior including existing exterior coated concrete.
EU-1	Zinc-epoxy-polyurethane system	Ferrous Metal	Exterior, exposed to direct sunlight, moderately corrosive non-immersed.
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.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	E-1
Coating Material:	Epoxy
Surface:	Metal
Service Condition:	Interior; exterior, covered, not exposed to direct sunlight, non-corrosive exposure.

Surface Preparation:

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.
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 09900-3.02 D.
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.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	E-1 (continued)
Application:	Field
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.
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.
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).
System Thickness:	10 mils dry film.
Coatings:	
Primer:	One coat at CSM's recommended dry film thickness.
Finish:	One or more coats at CSM's recommended dry film thickness per coat to achieve the specified system thickness.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	E-1-G
Coating Material:	Epoxy
Surface:	Galvanized Steel
Service Condition:	Interior; exterior, covered, non-corrosive exposure. Do not use in immersion service.
Surface Preparation:	
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.
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.
Application:	Field
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.
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).
System Thickness:	5 to 8 mils dry film.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification: E-1-G (continued)

Coatings:

Primer:	One coat at CSM's recommended dry film thickness.
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.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	E-5 (NSF 61 certified)
Coating Material:	Epoxy
Surface:	Metal
Service Condition:	Interior potable water tanks and reservoirs and other metal components in contact with water being treated and stored for potable use. Interior potable and non-potable carbon steel piping.
Surface Preparation:	
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.
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.
Application:	Field
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.
Ferrous Metal:	Prime coat shall be an epoxy primer compatible with the specified finish coats.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	E-5 (NSF 61 certified) (continued)
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).
System Thickness:	10 mils dry film.
Coatings:	
Primer:	One coat at the CSM's recommended dry film thickness.
Finish:	One or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	EU-1
Coating Material:	Zinc-Epoxy-Polyurethane System
Surface:	Ferrous Metal
Service Condition:	Exterior, exposed to direct sunlight, moderately corrosive, non-immersed.

Surface Preparation:

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.
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 09900-3.02 D. 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.
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.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	EU-1 (continued)
	For EU-1 over galvanized steel, delete the zinc rich primer.
Application:	Field
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.
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.
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.
Coatings:	
Primer:	One coat at CSM's recommended dry film thickness.
Intermediate:	One coat at CSM’s recommended dry film thickness.
Finish:	One coat at CSM's recommended dry film thickness per coat to meet the specified system thickness.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	L-1
Coating Material:	Latex
Surfaces:	Concrete, masonry, plaster, gypsum board.
Service Condition:	Interior and exterior including existing exterior coated concrete.

Surface Preparation:

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 03300.
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.
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.
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.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	L-1 (continued)
Gypsum Wallboard:	Tape joints and spackled nail heads shall be sanded smooth and dusted. Seal with PVA sealer for interior uses only.
Application:	Field
	Sealer or filler shall dry a minimum of 48 hours prior to primer application.
	Drying time between coats shall be as recommended by CSM.
System Thickness:	4 mils dry film.
Coatings:	
Primer:	One coat at CSM's recommended dry film thickness.
Finish:	Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	S-2
Coating Material:	Penetrating Water Repellent (Clear and Non-Film Building)
Surface:	Concrete Floors
Service Condition:	Exterior and Interior.
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.
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 03300
Application:	
General:	Drying time before placing into service shall be as recommended by the CSM for site conditions.
System Coverage:	Follow CSM's recommendations.
Color Selection:	Clear.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	S-3
Coating Material:	Penetrating Water Repellent (Clear & Non-Film Building)
Surface:	Concrete and Masonry Walls
Service Condition:	Exterior and Interior – For Anti-Graffiti Applications
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.
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 03300
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.
Application:	
General:	Drying time before placing into service shall be as recommended by the CSM for site conditions.
System Coverage:	Follow CSM's recommendations.
Color Selection:	Clear.

3.06 COATING SYSTEMS SCHEDULE (FINISH SCHEDULE)

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.

Location Description	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	Uncoated or E-1	
	2. Galvanized Metal decking	E-1-G	
	3. Equipment and Metal Appurtenances		
	a. Equipment, non immersed, unless otherwise specified		
	1) Indoors	E-1	FS 25051 Blue
	2) Outdoors	EU-1	FS 20040 Brown
	b. 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 09900-3.02)	Match existing color
	b) Outdoors	EU-1 without primer (see paragraph 09900-3.02)	Match existing color
	c. Diffusers and grilles on coated surfaces, unless otherwise specified		
	1) Indoors	E-1	Match background color
	2) Outdoors	EU-1	Match background color
	d. Diffusers and grilles on uncoated surfaces, unless otherwise specified		
	1) Indoors	E-1	FS 25051 Blue
	2) Outdoors	EU-1	FS 20040 Brown
	e. Electrical switchgear panels, unit substations, motor control centers, power transformers, distribution centers, and relay panels; indoors and outdoors	See paragraph 09900-3.03 I	ANSI 61 Grey (outside) FS 27880 White (inside)

Location Description	Surface	Coating System Identification	Standard Color
	f. Instrumentation panels, graphic indicating panels, indicating and transmitting field panels, unless otherwise specified		
	1) Indoors	See paragraph 09900-3.03 I	FS 26306 Grey (outside) FS 27880 White (inside)
	2) Outdoors	See paragraph 09900-3.03 I	FS 27722 White (outside) FS 27880 White (inside)
	g. 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 09900-3.02 F)	FS 26306 Grey
	b) Outdoors	EU-1 without primer (see paragraph 09900-3.02 F)	FS 26306 Grey (Electrical) FS 27722 White (Instrumentation)
	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	FS 25051 Blue
	2) Outdoors – noncorrosive	EU-1	FS 20040 Brown
	b.		
	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

Location Description	Surface	Coating System Identification	Standard Color
	d. Conduit, outlets and junction boxes, lighting transformers, lighting, communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps and supports on uncoated surfaces, unless otherwise specified		
	1) Indoors	E-1	FS 25051 Blue
	2) Outdoors	EU-1	FS 20040 Brown
	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 09900-3.02 F)	Match existing color
	b) Outdoors	EU-1 without primer (see paragraph 09900-3.02 F)	Match existing color
	4. Concrete, Grout, Masonry and Plaster		
	a.		--
	b. Outside concrete walls below grade common with dry area or room	In accordance with Section 07100)	--
	c. Walls and ceilings		
	1) Precast concrete or colored masonry	S-3	--
	2) Outdoors, unless otherwise specified	S-3	--
	3) Indoors, unless otherwise specified	S-3	
	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

Location Description	Surface	Coating System Identification	Standard Color
	2) Aluminum	Uncoated	--
	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 09900-3.02 F)	Match existing color
	(2) Outdoors	EU-1 (see paragraph 09900-3.02 F)	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 09900-3.02 F)	Match existing color
	(2) Outdoors	EU-1 without primer (see paragraph 09900-3.02 F)	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 09900-3.02 F)	Match existing color

Location Description	Surface	Coating System Identification	Standard Color
	b) Outdoors	EU-1 without primer (see paragraph 09900-3.02 F)	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	--
	2) Damaged, exposed, or modified by work in this contract		
	a) Indoors	E-1 (see paragraph 09900-3.02 F)	Match existing color
	b) Outdoors	EU-1 without primer (see paragraph 09900-3.02 F)	Match existing color
	8. Aluminum Flashing, Light Standards, Supports, and Louvers		
	Indoors and outdoors, unless otherwise specified	Uncoated	--
	9. Precast Concrete Metalwork		
	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) Filtration and GAC Vessals		
	a) Inside of tank	E-5	See Note 1
	b) Outside of tank	EU-1	FS 25051 Blue
	2) Potable steel water storage tanks		

Location Description	Surface	Coating System Identification	Standard Color
	a) Inside of tank	E-5	See Note 1
	b) Outside of tank	EU-1	FS 25051 Blue
	3) Fiberglass tank	Uncoated	--
	f.	Uncoated	--
	g. Buried, sleeve-type and flanged pipe, couplings, valves, mechanical and electrical penetrations	M-1 or M-2	Manufacturer's color
K. Administration Building	1. Outdoors		
	a. Equipment on roof	EU-1	FS 25051 Blue
	b. Walls	Uncoated	--
	2. Room 5401 Lobby		
	a. Floor	Epoxy terrazzo	National Mosaic Assoc. Std S109
	b. Base	Epoxy terrazzo	NMAS S109
	c. Plaster walls	L-1	FS 23617 Beige
	d. Steel deck ceiling	L-3	FS 23617 Beige
	e. Steel roof trusses	L-3	FS 23617 Beige
	f. Doors	L-3	FS 20040 Brown
	g. Door frames	L-3	FS 23617 Beige
	3. Room 5402 Clerical Area		
	a. Floor	Epoxy terrazzo	NMAS S109
	b. Base	Epoxy terrazzo	NMAS S109
	c. Plaster walls	L-1	FS 23617 Beige
	d. Steel deck ceiling	L-3	FS 23617 Beige
	e. Steel roof trusses	L-3	FS 23617 Beige
	f. Doors	L-3	FS 20040 Brown
	g. Door frames	L-3	FS 23617 Beige
	h. Filing cabinets	Shop coated	Steelcase Tan

Notes:
1. Owner will select color from coating manufacturer's list of EPA approved colors for potable water.

3.07 INSPECTION AND TESTING BY OWNER

A. 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.

B. 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 09900. These inspections may include the following:

1. Inspect materials upon receipt to ensure that are supplied by the CSM.

2. Inspect to verify that specified storage conditions for the coating system materials, solvents and abrasives are provided.

3. Inspect and record findings for the degree of cleanliness of substrates.

4. Inspect and record the pH of concrete and metal substrates.

5. Inspect and record substrate profile (anchor pattern).

6. Measure and record ambient air and substrate temperature.

7. Measure and record relative humidity.

8. Check for the presence of substrate moisture in the concrete.

9. Inspect to verify that correct mixing of coating system materials is performed in accordance with CSM's instructions.

10. 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.

11. Perform adhesion testing.

12. Measure and record the thickness of the coating system.

13. Inspect to verify proper curing of the coating system in accordance with the CSM's instructions.

14. 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. Contractor shall conduct a final inspection to determine whether coating system work meets the requirements of the specifications.

B. 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.

C. Any rework required shall be marked. Such areas shall be recleaned and repaired as specified at no additional cost to the Owner.

09900-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 (e.g. E-1)		Coating Type (e.g. Epoxy, etc.)	

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			

Step	Description		Name	Signature	Date
		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			
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	GC QC			

Step	Description		Name	Signature	Date
	to Coating System Following Testing.	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			

**END OF SECTION **

Navajo Nation
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

BODAWAY-GAP WELL, STORAGE TANK AND PIPELINE

DIVISION 10

SPECIALTIES

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SECTION 10441

WARNING SIGNS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies informational and accident prevention signs.

1.02 OPERATING AND DESIGN REQUIREMENTS

A. GENERAL:

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.

In addition to the signs identified on the schedule in Part 3 of this section, the following shall be provided:

1. "Caution Automatic Equipment May Start At Any Time" signs shall be provided in accordance with paragraph 11000-2.07.

B. DESIGN REQUIREMENTS:

1. SIZE: Sign size shall be as follows:

A - 14 inch x 20 inch
B - 10 inch x 14 inch
C - 7 inch x 10 inch

2. TYPE: The sign type shall be as follows:

Type	Message
I	CAUTION--AUTOMATIC EQUIPMENT MAY START AT ANY TIME
II	DANGER--480 VOLTS
VI	CAUTION--WAIT 5 MINUTES AFTER FAN HAS BEEN SWITCHED ON BEFORE ENTERING BUILDING
VII	DANGER--240 VOLTS

X	DANGER-CONFINED SPACE-HAZARDOUS ATMOSPHERE
XIII	RESTRICTED AREA--AUTHORIZED PERSONNEL ONLY
XVI	LOCK OUT SWITCH BEFORE WORKING ON EQUIPMENT

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

1. Sign manufacturer's product data and cut sheets showing sign materials, sizes, dimensions, fonts, colors, and any other applicable data.

PART 2--PRODUCTS

2.01 GENERAL

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

Signs shall be 0.100-inch thick fiberglass with embedded fadeproof legends.

PART 3--EXECUTION

Signs shall be distributed as follows:

Location	Number	Size	Message	Mount
Pump Station— interior				
Pump Room	4	C	I	Wall
Pumps	1 each	B	XVI	Wall or Post
Pump Station - exterior				
Pump Room	1	C	VIII	Door
Gate	1	C	VIII	Fence
Gate	1	C	XIII	Fence
All 240 volt electrical equipment	1 each	C	VII	Equipment Door
All 480 volt electrical equipment: SES, Switchboard, Motor Starter, VFD, Panelboard,	1 each	C	II	Equipment Door

Location	Number	Size	Message	Mount
etc.				
Pipeline Vaults				
Access Hatches and Manhole Entries	6	C	X	Underside of Hatch or Wall near Ladder

END OF SECTION

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SECTION 10520

FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Furnish and install fire protection specialties where shown on the drawings and as specified herein.

1.2 QUALITY ASSURANCE

A. Portable Fire Extinguishers: National Fire Protection Association - NFPA 10.

B. Provide new portable fire extinguishers which are UL-listed and bear UL "Listing Mark" for type, rating and classification of extinguisher indicated. Provide extinguisher with UL-listed and FM rated pressure indicating gauge.

1.3 SUBMITTALS

A. Submit manufacturer's product data highlighting all information to show compliance with this specification. Include schedule indicating type, size and location of fire protection specialties.

1.4 PRODUCT HANDLING

A. Use all means necessary to protect materials of this section before, during, and after installation and to protect installed work and materials of all other trades.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. J.L. Industries, General Triplex, Larsen's Manufacturing Company or equal.

2.2 FIRE EXTINGUISHERS

A. Wall mounted with bracket
   1. Provide Mark Bracket, MB 846 wall bracket as manufactured by J.L. Industries or equal.
   2. Provide one multi-purpose fire extinguisher, 10 pound capacity, 4A-80BC, Class ABC dry chemical type.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine substrates to which construction attaches or abuts, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of construction of the work of this section.

B. Report conditions contrary to contract requirements that would prevent a proper installation. Do not proceed with the installation until unsatisfactory conditions have been corrected.

C. Failure to call attention to defects or imperfections will be construed as acceptance and approval of substrate conditions. Installation indicates acceptance of substrates with regard to conditions existing at the time of installation and full responsibility for completed work.

D. Correct conditions detrimental to the proper and timely completion of the work.

3.2 INSTALLATION

A. Install the work of this section in strict accordance with the manufacturer's recommendations as approved by the Owner.

B. Anchor all components firmly into position for long life under hard use.

C. Installation to be in operating condition in perfect adjustment.

PART 4 QUANTITY

A. Provide and install (4) fire extinguishers. Install in locations as noted on plans as unless directed otherwise by the Local Authority having Jurisdiction.

END OF SECTION 10520

Navajo Nation
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

CAMERON PUMP STATIONS AND PRESSURE RELIEF VALVES

DIVISION 11

EQUIPMENT

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SECTION 11000

GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

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.

B. EQUIPMENT LISTS:

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.

1.02 QUALITY ASSURANCE

A. ARRANGEMENT:

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:

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.

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:

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.

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 11000-C specified in Section 01999, 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.*

D. BALANCE:

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:

$$U_{per} = 6.015 \frac{GW}{N}$$

Where:

U_{per} = permissible imbalance, ounce-inches, maximum

G = Balance quality grade, millimeters per second

W = Weight of the balanced assembly, pounds mass

N = Maximum operational speed, rpm

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

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.

Threaded flanges shall have a standard taper pipe thread conforming to ANSI B1.20.1. Unless otherwise specified, flanges shall be flat faced.

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

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 50,000 hours. The rating life shall be determined using the maximum equipment operating speed.

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.

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.

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

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.

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.

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:

Seals for water and wastewater pump shafts shall be 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:

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.

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.

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.

Candidate seals include:

1. 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.

2. AESSEAL RDS seals with Cyclops bushing.

3. John Crane 3710 seals with Type 24SL bushing.

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.

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 – NOT USED:

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 11000-2.04.B for the applicable pump and operating conditions.

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.

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

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.

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

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

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

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 Divisions 15 and 17, respectively.

2.09 NAMEPLATES

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

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 01660), 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

Anchor bolts shall be 316 stainless steel and designed for lateral forces for both pullout and shear in accordance with the provisions of Section 05501. Unless otherwise stated in the individual equipment specifications, anchor bolt materials shall conform to the provisions of Section 05501.

2.12 SPARE PARTS

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

Installation of equipment accessories included in this section shall be as recommended by the equipment manufacturer unless otherwise specified in the individual equipment specification section.

END OF SECTION

SECTION 11002

RIGID EQUIPMENT MOUNTS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

1. This section specifies minimum requirements for rigid equipment mounts. Completed equipment mounts shall consist of equipment pads, equipment anchors, and mounting plates (baseplates, soleplates, or fabricated steel frames) set in grout.

2. Equipment mounts shall conform to the requirements specified in the Equipment Mounting Schedule included in this specification. Where equipment mounting requirements are not specifically identified in the Equipment Mounting Schedule, the default mounting configuration for equipment shall consist of Concrete Equipment Pads per details on Sheet S-008 of the structural drawings, mounting plates leveled within 0.005 inch/foot, anchored to the equipment pad with cast-in-place equipment anchors, equipment anchor sleeve length of 10 times the bolt diameter, and the mounting plate 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 individual equipment specifications. Rigid equipment mounts conforming to the requirements of this Section shall be furnished for the equipment pad and other equipment mounting components supporting the vibration isolation system.

B. DEFINITIONS:

Specific equipment mounting 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.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. Referenced documents 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.

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, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ACI 318, Appendix D	Building Code and Commentary, Anchorage to Concrete
ANSI/HI 1.4	Centrifugal Pumps – Installation, Operation and Maintenance
ANSI/HI 2.4	Vertical Pumps – Installation, Operation and Maintenance
API RECOMMENDED PRACTICE 686	Recommended Practices for Machinery Installation and Installation Design
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

Reference	Title
IBC 2012	International Building Code 2012 (including local amendments)

B. QUALITY CONTROL BY CONTRACTOR:

To demonstrate conformance with the specified requirements for rigid equipment mounts, the CONTRACTOR shall provide the services of an independent testing laboratory that complies with the requirements of ASTM E329. The testing laboratory shall sample and test materials installed as part of rigid equipment mounts as specified in this Section. Costs of testing laboratory services shall be borne by the CONTRACTOR.

Where epoxy grout is specified in individual equipment specifications, the CONTRACTOR shall 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 shall perform training and quality control of epoxy grout installation for rigid equipment mounts as specified in this section.

C. SPECIAL INSPECTION FOR EQUIPMENT ANCHORS

Equipment anchors shall comply with special inspection requirements specified in Section 05501**.**

1.03 SUBMITTALS

The following information shall be provided in accordance with the submittal requirements specified in Section 01300.

1. A copy of this specification section, including addendum updates, (referenced sections need not be included for Section 11002) 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 shall be sufficient cause for rejection of the entire submittal with no further consideration. Copies of this specification section shall be numbered and marked (specification number and equipment

number) for inclusion (filing) with submittal materials furnished for individual equipment specifications.

2. Name, employer, and statement of qualification for mechanical contractor who will install rigid equipment mounts.

3. 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 11002-1.02 B. 2.

4. Shop drawings for equipment pads, equipment anchors, and baseplate, soleplate or fabricated steel frame 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 fabricated steel frames shall be numbered and marked (specification number and equipment number) for inclusion (filing) with the associated equipment submittal requirements.

PART 2—PRODUCTS

2.01 GENERAL

Equipment mounts shall conform to the requirements specified in the Equipment Mounting Schedule.

Equipment and drivers shall be rigidly mounted on a common mounting plate and grouted into place on a concrete equipment pad unless alternate requirements are specified in the Contract Drawings or the Equipment Mounting Schedule in this section. Unless otherwise specified in the individual equipment specification, mounting plates shall be anchored to equipment pads with a layer of grout between the equipment pad and the mounting plate.

2.02 EQUIPMENT PADS

A. MATERIALS

1. Equipment pads shall be reinforced concrete as shown in the structural drawings on Sheet S-008.

2. Minimum dimensions for equipment pads are shown on structural drawings where the equipment pad is required to provide a minimum mass for vibration dampening.

B. EQUIPMENT PAD DRAINAGE:

1. Equipment pads shall be furnished with drains if required for equipment operation.

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 hatch 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.

Equipment Mounting Schedule					
Equipment Number	Equipment Pad Detail	Mounting Plate Leveling Tolerance (inch/foot)	Equipment Anchor Sleeve Length	Grout Type	Application Notes
Fe/Mg Filters, GAC Vessels	Detail Type A / S-008	0.02	Per Manufacture Requirement	Non – shrink	
Freestanding floor-mounted electrical panels and equipment	Detail Type E / S-008	0.02	Not Required	Not Required	Mounting for electrical equipment such as MCC, and PLC
Chlortainer	Detail Type D / S-008	0.02	Per Manufacture Requirement	Non – shrink	
Chlorine Pumps	Detail Type A / S-008	0.02	Per Manufacture Requirement	Non – shrink	
Reclaim Pump	Detail Type A / S-008	0.02	Per Manufacture Requirement	Non – shrink	
Sludge Mixing / Transfer Pump	Detail Type E / S-008	0.02	Per Manufacture Requirement	Non – shrink	

2.03 EQUIPMENT ANCHORS:

A. EQUIPMENT ANCHOR MATERIALS

1. Equipment anchors shall be 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.

2. Post-installed anchors (wedge, sleeve, undercut, expansion, and adhesive anchors) shall conform to the requirements of Section 05501.

3. Adjustable canister anchors shall be cast-in-place pre-manufactured adjustable anchor inserts. Adjustable canister anchors shall 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. Adjustable canister anchors shall be Jakebolts as manufactured by Unisorb, Heavy Duty Adjustable Anchors as manufactured by Deco, Rowan Adjustable Canister Anchor Bolt, or approved equal.

4. Equipment anchor materials shall be 316 Stainless Steel, Condition CW per ASTM F593.

B. EQUIPMENT ANCHOR DESIGN:

1. The size (diameter) of anchors for clamping/fastening mounting plates to equipment pads shall be as specified by the equipment manufacturer.

2. Equipment anchor size, embedment, and edge distance shall comply with the International Building Code (IBC 2006) and shall be sufficient to resist the maximum lateral and vertical forces specified in Section 01900.

3. The CONTRACTOR shall furnish equipment anchor calculation submittals for all pumps, MCC, and Lighting Transformer. Equipment anchor calculations shall be furnished as product data and submitted with equipment submittals. Equipment anchor calculations shall be sealed by a registered structural ENGINEER licensed in the State of Arizona.

C. EQUIPMENT ANCHOR TENSION

1. Unless alternate bolt torque/tension requirements are specified by the equipment manufacturer, equipment anchors shall be tightened to provide a final clamping force that produces a tensile stress of 15,000 psi in each

equipment anchor. Adjustable canister anchors shall be tightened to the manufacturer's maximum safe working load. Equipment anchors consisting of Post-installed anchors shall be tightened 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

3. Prior to leveling and grouting mounting plates, grouted equipment anchors shall be pull tested to the values specified in the following table.

Anchor diam. (in)	3/8	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4	1-1/2
Pull test load (kips)	2.1	3.8	6.1	9.1	13	17	22	28	43

D. ANCHOR SLEEVES

1. Equipment anchors shall be fitted with sleeves as specified in the Equipment Mounting Schedule. Sleeve length for equipment anchors shall be 15 times the bolt diameter unless otherwise specified in the Equipment Mounting Schedule. Sleeves may be installed at the CONTRACTOR'S option if not specified in the Equipment Mounting Schedule.

2. Not Used.

3. Anchor sleeves shall be flexible polyurethane foam, steel cylinder/tubes, or ribbed plastic sleeves.

4. Fill steel cylinders/tubes and ribbed plastic sleeves with a flexible room temperature vulcanizing (RTV) sealant prior to embedment/installation.

2.04 MOUNTING PLATES

A. GENERAL:

1. All baseplates, soleplates, and fabricated steel frames shall have edges of surfaces bearing on grout rounded to a radius of not less than 0.25 inch.

2. Perimeter corners of baseplates, soleplates, or fabricated steel frames shall be rounded to a radius of not less than 2.0 inches to avoid producing stress risers on the grouted foundation.

3. Grout pouring holes (minimum 4 inches in diameter for epoxy grout, minimum 2.5 inches in diameter for cementitious non-shrink grout) shall be provided in all baseplates and soleplates and all baseplates and soleplates shall have air release holes.

4. Grout relief or vent holes (minimum 1 inch in diameter) shall be provided in all baseplates and soleplates.

5. Mounting holes for equipment anchors shall be drilled through baseplates, soleplates, and fabricated steel frames.

6. Mounting holes for equipment anchors shall be drilled. Mounting holes shall not be burned out and they shall not be open slots.

7. Terminations requiring connections to baseplates and soleplates shall be 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.

8. 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.

9. Where baseplates, soleplates, or fabricated steel frames are leveled using jackscrews, jackscrew threads shall be tapped in thickened pads or otherwise in sufficient metal to provide ease in adjusting level.

10. Mounting pads and/or mounting surfaces for baseplates, soleplates, and fabricated steel frames shall be milled flat after all welding and stress relieving and shall be coplanar within 0.0005 inch per foot in all directions. Baseplates shall be pre-grouted prior to milling.

11. Baseplates, soleplates, and fabricated steel frames shall provide common support for the equipment and driver (and flywheel, if one is specified).

12. Baseplates, soleplates, and fabricated steel frames for equipment with drivers 20 horsepower and greater shall be furnished with transverse alignment (horizontal) positioning jackscrews for alignment of equipment drivers on horizontal surfaces of baseplates.

13. Alignment/positioning jackscrews shall be in perpendicular directions in a horizontal plane at the mounting position for each corner or foot of the equipment driver. (Additional jackscrews shall be 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 shall be fitted with RK Fixators as manufactured by Unisorb, or approved equal.

    a. Fixators shall be installed at mounting surfaces for drivers.

    b. Fixators shall be 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 shall be plate or fabricated structural steel mounting plates with thickened steel mounting pads for bolting equipment to the mounting plate.

2. Fabricated steel frames shall be rectangular in shape, excepting fabricated steel frames for centrifugal refrigeration machines and pumps which may be T- or L-shaped fabricated steel frames to accommodate the equipment driver and accessories.

3. Fabricated steel frames for split case pumps shall include supports for suction and discharge elbows, if required by the specified configuration.

4. Perimeter members shall be 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 shall be furnished with mounting pads welded to the fabricated steel frame.

6. Surfaces of fabricated steel frames in contact with grout shall be sandblasted to white metal per SSPC SP-5.

7. Apply a high-strength epoxy primer as specified in 11002-2.06 within 8 hours of sandblasting the fabricated steel frame.

C. BASEPLATES:

1. Baseplates shall be welded steel, cast steel, or cast iron with thickened mounting pads for bolting equipment to the baseplate.

2. Internal stiffeners shall be provided on all cast and fabricated baseplates and shall be designed to allow free flow of grout from one section of the baseplate to another.

3. The minimum acceptable opening in cross bracing and stiffeners shall be 2 inches high by 6 inches wide.

4. All welds shall be continuous and free from skips, blowholes, laps and pockets.

5. Baseplates shall be pre-grouted at the factory after all welding has been completed and prior to machining the mounting pads on the baseplate. Baseplates that have not been pre-grouted at the factory shall be pre-grouted in the field by removing the equipment from the baseplate, inverting the baseplate, and pre-grouting as specified in this Section.

6. The underside of baseplates shall be sandblasted to white metal per SSPC SP-5 prior to pre-grouting.

7. Pre-grouting shall be completed within 8 hours of sandblasting.

8. Pre-grouting shall fill the underside of the baseplate to the bottom edges of the baseplate.

9. Cast iron baseplates shall be sealed to prevent surface bleeding prior to shipment to the project site.

D. PLATE STEEL SOLEPLATES:

1. Plate steel soleplates shall be not less than 1.0 inch thick for equipment with drivers greater than 30 horsepower.

2. Plate steel soleplates shall be furnished with grout keys/lugs or stiffeners on the underside of the soleplate.

3. Excepting grout keys, grout pour holes, vent holes, and attachment hardware (nuts, bolts, tapped holes, etc.) the underside of plate steel soleplates shall be a flat uniform horizontal surface.

4. The underside of plate steel soleplates shall be scribed with the words "THIS SIDE DOWN" using welding rod material prior to milling the mounting pads for equipment or mounting surfaces.

5. Plate steel soleplates without grout pouring holes are acceptable provided that no dimension of the soleplate (width or length) exceeds 18 inches.

6. Surfaces of plate steel soleplates in contact with grout shall be sandblasted to white metal per SSPC-SP-5 prior to shipment to the project site.

7. Apply a high-strength epoxy primer as specified in 11002-2.06 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, the equipment shall be supported at the feet or mounting surfaces on individual plate steel soleplates, which shall be leveled and grouted into place on the individual piers or equipment pads as specified in this section. Where multiple soleplates are installed for an equipment installation, soleplates shall be installed coplanar within 0.002 inch/foot.

E. POLYMER CONCRETE SOLEPLATES:

1. Polymer Concrete Soleplates shall be pre-cast soleplates consisting of polymer concrete with stainless steel inserts for equipment mounting.

2. Mounting surfaces on Polymer Concrete Soleplates shall be coplanar within 0.002 inch/foot. Polymer Concrete Soleplates shall be furnished with a uniform horizontal surface over the entire underside of the mounting plate.

3. Excepting grout keys, grout pour holes and vent holes, the underside of soleplates shall provide a flat uniform horizontal surface.

4. Polymer Concrete Soleplates shall be PoxyBase as manufactured by Basetek, Chembase as manufactured by Goulds, or approved equal.

F. CORROSION RESISTANT FRP BASEPLATES

1. Corrosion Resistant FRP Baseplates shall be pre-formed fiber reinforced plastic fabrications.

2. Corrosion Resistant FRP Baseplates shall be products of the manufacturer of the equipment that is mounted on the baseplate.

2.05 GROUT FOR EQUIPMENT PADS

A. EPOXY GROUT FOR EQUIPMENT MOUNTING:

Where epoxy grout is specified in the Equipment Mounting Schedule, grout for setting bearing surfaces of baseplates, soleplates, and fabricated steel frames on equipment pads shall be Epoxy Grout for Equipment Mounting as specified in Section 03600. Where the term epoxy grout is used in the context of details and specifications for equipment mounting it shall mean Epoxy Grout for Equipment Mounting as specified in Section 03600.

B. CEMENTITIOUS NONSHRINK GROUT:

Where non-shrink grout is specified in the Equipment Mounting Schedule, Cementitious Non-shrink Grout, specified in Section 03600, 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 shall mean Cementitious Non-shrink Grout as specified in Section 03600. Training and quality control by the grout manufacturer's technical representative is not required for rigid equipment mounts installed with cementitious non-shrink grout.

2.06 EPOXY PRIMER

Epoxy primer shall be a high-strength, lead free, chrome free, and rust inhibiting two-component epoxy primer specifically designed for use on metal substrates and in conjunction with epoxy grout. The epoxy primer's bond strength to sandblasted metal shall not be less than 1500 psi. Epoxy primer shall be Phillybond Phillyclad 1000 Series, or approved equal.

2.07 ANTI-SEIZE/ANTI-GALLING COMPOUND

Anti-seize or anti-galling compound shall be a molybdenum disulfide and graphite combination in aluminum complex base grease conforming to MIL-PRF-907E. Acceptable products include Jet Lube 550 by Jet Lube, Inc., E-Z Break by LA-CO, or approved equal.

2.08 PRODUCT DATA

The following information shall be provided in accordance with the product data requirements specified in Section 01300:

1. Equipment anchor calculations demonstrating compliance with paragraph 11002-2.03 B.

2. Results of grout strength tests, as specified in paragraph 11002-3.03 C.

3. Completed Rigid Equipment Mount Installation Inspection Checklist Forms (11002-A), as specified in paragraph 11002-3.02 B.

4. List of CONTRACTOR's equipment installation staff that has completed epoxy grout manufacturer's grout installation training specified in paragraph 11002-3.02 A.

PART 3--EXECUTION

3.01 GENERAL

A. GENERAL REQUIREMENTS:

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, and 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 shall be performed by power wire brushing, power sanding, power grinding, power tool chipping or power tool descaling. Cleaning shall impart a minimum profile of 1.0 mil.

2. Prior to placement on the equipment pad for leveling, exposed grout surfaces of pre-grouted baseplates shall be roughened and wiped 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 prior to placement of the baseplate on the equipment pad for leveling.

4. Grout for equipment mounting shall be as specified in the Equipment Mounting Schedule.

5. Grouting for installation of equipment on equipment pads shall take place prior to connecting any field piping or electrical and instrumentation systems.

6. Unless the CONSTRUCTION MANAGER accepts an alternate installation procedure in writing, baseplates, soleplates, and fabricated steel frames shall be leveled and grouted with the equipment removed.

7. Pumps shall be installed in accordance with this section and ANSI/HI 1.4 or ANSI/HI 2.4, as appropriate for the type of pumping equipment installed.

8. Connecting piping with flexible connections and/or expansion joints shall be anchored such that the intended function of these joints is maintained in the piping system without imposing strain on the equipment connections.

B. ALTERNATE PIPING CONNECTIONS:

Where an equipment manufacturer's installation requirements include a rigid connection between the machine and connecting piping systems, the CONTRACTOR shall 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:

1. The equipment pad shall be installed as shown on the detail specified in the Equipment Mounting Schedule.

2. The baseplate, soleplate, or fabricated steel frames supporting the equipment shall be installed, leveled, and grouted in place as specified in this section.

3.

4. The piping shall be installed and aligned to the equipment connections and the field piping connections 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 shall be bolted up and pressure-tested.

5. All piping shall be fully supported by supports designed to accept their full weight and thrust forces.

6. The final sections of piping shall be aligned with the equipment and field connections without the use of jacks, chain falls, or other devices to force it into alignment.

7. The final piping joints shall be welded only after the previous steps have been completed and accepted by the CONSTRUCTION MANAGER.

3.02 EPOXY GROUT TRAINING AND QUALITY CONTROL

A. EPOXY GROUT TRAINING

Prior to commencing rigid equipment mount installation work on equipment pads, the CONTRACTOR shall furnish the services of a grout manufacturer's technical representative to conduct a training for the workers who will be using epoxy grout for rigid equipment mount installations. The training shall be not less than 4 hours in length and shall cover 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, however, shall not be construed as relieving the CONTRACTOR of overall responsibility for this portion of the work. The epoxy grout manufacturer shall furnish a list of training attendees who have been satisfactorily trained to perform epoxy grout installation for equipment mounting.

B. EPOXY GROUT QUALITY CONTROL

For equipment mounted with epoxy grout, the epoxy grout manufacturer's technical representative shall provide quality control services for epoxy grout installation in rigid equipment mounts. The epoxy grout manufacturer's technical representative shall be 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.

Specifically, the epoxy grout manufacturer's technical representative shall perform the following services for at least one rigid equipment mount installation for each equipment type and size installed with epoxy grout:

1. Inspect ambient conditions during various phases of epoxy grouting installation for conformance with the epoxy grout manufacturer's requirements.

2. Inspect the surface preparation of concrete substrates onto which epoxy grout materials are to be applied, for conformance to the specified application criteria, including but not limited to substrate profile, degree of cleanliness, and moisture.

3. Inspect the surface preparation of the metallic substrates onto which the epoxy primer is to be applied.

4. Inspect the epoxy-primed metallic substrate for coverage and adhesion.

5. Inspect preparation and application of epoxy grout form work for conformance to the specifications.

6. Inspect and record that the "pot life" of epoxy grout materials is not exceeded during installation.

7. Inspect epoxy grout for cure.

8. Inspect and record that localized repairs made to grout voids conform to the specification requirements.

9. Conduct a final review of completed epoxy grout installation for conformance to these specifications.

10. Attest to conformance of the CONTRACTOR's work by signing appropriate entries in the "Rigid Equipment Mount Inspection Checklist," form 11002-A in Section 01999.

3.03 INSTALLATION

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. Roughened surface profile shall be 0.25inch 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. The chipped surface of the concrete shall be 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. All dust, dirt, chips, oil, water, and any other contaminants shall be removed and the surface protected with plastic sheeting until grout is installed.

10. Concrete equipment pad surfaces that have been finished smooth and level for use as leveling positions shall be protected from damage during chipping activities. Alternatively, leveling positions may be restored on chipped surfaces. Leveling positions shall be restored 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 shall be installed level on the epoxy putty.

B. LEVELING:

1. Except where union rules require installation by another trade, all equipment and machinery shall be mounted and leveled by a qualified mechanical contractor.

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 shall be leveled to the tolerance specified in the Equipment Mounting Schedule or as otherwise required by the equipment manufacturer, if more stringent.

5. An anti-seize or anti-galling compound specified in paragraph 11002-2.07 shall be applied to all equipment anchor threads prior to beginning baseplate, soleplate, or fabricated steel frame leveling.

6. All baseplates, soleplates, and fabricated steel frames shall be leveled 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. Leveling equipment and tools shall be 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 (including 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. Leveling blocks shall be machined flat on all horizontal surfaces and placed under the baseplate or soleplate at each equipment anchor.

11. Shims shall be pre-cut stainless steel, slotted for removal after grouting. Leveling blocks and shims shall be coated with a light oil just prior to beginning the leveling and grouting work. Shims shall be placed 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. Bolt tension to fix the position of mounting plates during grouting shall be 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.

C. GROUTING:

1. Design forms for a minimum of 6 inches hydrostatic head above the final elevation of the grout.

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 shall 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. Vertical and horizontal edges of the grout shall have 45-degree chamfers as specified in equipment pad details. The 45-degree perimeter chamfer strip shall be located 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. Final elevation of grout on fabricated steel frames shall be at the top of the lower flange of the perimeter I-beams or C-channel.

13. Top of grout elevation for baseplates and soleplates shall be at least 0.125 inch but not more than 0.5 inch above the bottom or underside of the perimeter edge of the baseplate or soleplate.

14. Seal equipment anchor sleeves to protect the sleeved length of the anchor from contact with grout.

15. Wrap exposed portions of equipment anchors with duct tape to protect them from grout splatter and to prevent bonding to grout.

16. Adjust ambient temperature to maintain mounting plate, foundation, and grout temperatures to grout manufacturer's recommended temperature.

17. Mix grout for equipment mounting in accordance with the grout manufacturer's written recommendations.

18. Epoxy grout shall be placed in a manner that avoids air entrapment, using a head box to pour grout into the grout holes.

19. 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.

20. Pour grout through a head box into grout pouring holes.

21. When the head box is moved to the next grout hole, a 6-inch standpipe shall be placed over the grout hole and filled with grout.

22. Use of vibrating tools and/or jarring (rapping or tapping) forms to facilitate grout flow is not permitted during placement of epoxy grout.

23. 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.

24. Grout placement shall be continuous until all portions of the space beneath the baseplate, soleplate, or fabricated steel frame have been filled.

25. Prepare subsequent batches of grout prior to depleting the preceding batch.

26. Maintain grout height in standpipes after the space under the baseplate, soleplate, or fabricated steel frame has been filled.

27. 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) the standpipes shall be removed and excess grout cleaned from all surfaces.

28. Check for leaks throughout grout pours. Leaks shall be repaired immediately to prevent formation of voids.

29. Check baseplate, soleplate, or fabricated steel frame level and elevation before the grout sets.

30. Cure grout in accordance with the grout manufacturer's written instructions.

31. Where specified in the individual equipment specifications, a grout sample shall be taken for each equipment pad.

    a. Samples shall be placed in a cylinder of sufficient size to yield three 2-inch cubes as test samples.

    b. Samples shall be tagged 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 shall be tested by the independent testing laboratory specified in paragraph 11002-1.02 B.

    f. Test results shall be reported directly to the CONSTRUCTION MANAGER.

D. COMPLETION:

1. Upon acceptance by the CONSTRUCTION MANAGER and the equipment manufacturer's representative and after the grout has reached sufficient strength, grout forms and block outs at leveling positions shall be removed. Leveling blocks and shims or wedges and support plates shall be removed, and leveling nuts and jack screws shall be backed off 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. The equipment anchor nuts shall be tightened, using calibrated indicating torque wrenches, to develop the full bolt tension specified in 11002-2.03 C.

3. Equipment anchor nuts shall be tightened 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, block outs (pockets) for access to leveling nuts, leveling blocks and shims, or wedges shall be filled with the grout material installed under baseplates, soleplates, or fabricated steel frames and pointed after the equipment anchor nuts have been tightened to final values. Jackscrews shall be removed and holes in the baseplate, soleplate, or fabricated steel frames filled 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. Vertical movement at each equipment anchor shall be measured and recorded during loosening and retightening and shall not exceed 20 micrometers (0.001 inch). Vertical movement shall be measured 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. Soft foot conditions shall be 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. Grout voids shall be sufficient cause for removal and reinstallation of grout and baseplates, soleplates, or fabricated steel frames. Grout voids shall be marked. At the discretion of

the CONSTRUCTION MANAGER, grout voids may be repaired as specified in Chapter 5, Section 3.16 of API RP 686.

3.04 FINAL INSPECTION

The CONSTRUCTION MANAGER will conduct a final inspection with the CONTRACTOR for conformance to requirements of this section.

END OF SECTION

SECTION 11005

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 11000 – General Requirements for Equipment

B. Section 11002 – Rigid Equipment Mounts

C. Section 11020 – Vibration and Critical Speed Limitations

D. Section 11050 – 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 Section11002, 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 11020

VIBRATION AND CRITICAL SPEED LIMITATIONS

PART 1--GENERAL

1.01 DESCRIPTION

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:

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: 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

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: 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:

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

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

Manufacturer's certified data showing location of critical speeds in relation to operating speeds shall be provided as product data in accordance with Section 01300.

END OF SECTION

SECTION 11050

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, where found in individual pump specifications, supersede requirements of this section.
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 11050) 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
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 RElE 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.

Reference	Title
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.
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 installatio
   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.F NPSH margin limitations. Pump selections that do not provide the specified margin will be rejected.

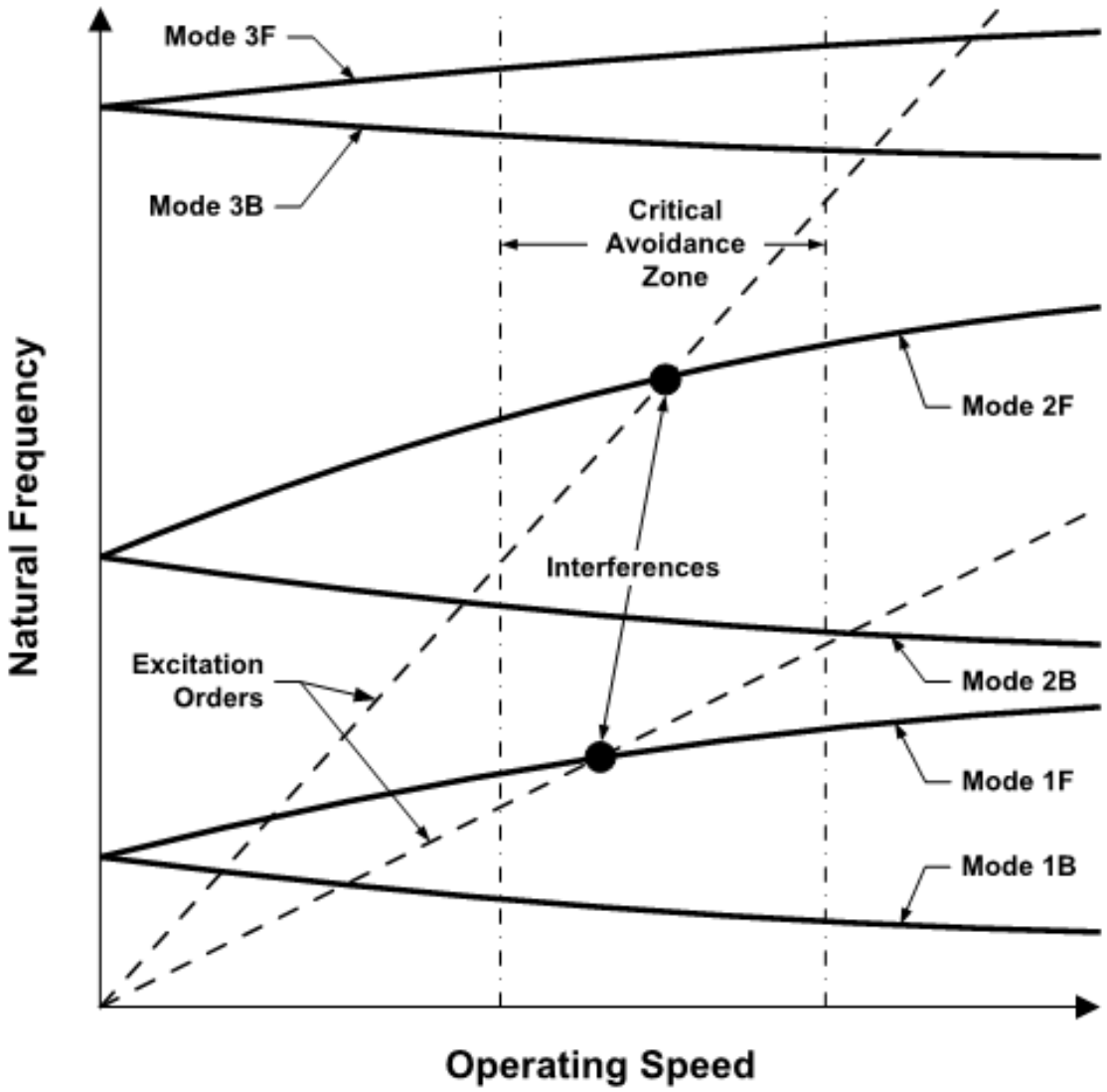
3. General design criteria:
    a. Select pumps furnished under sections referencing this section that are designed in accordance with applicable portions of ANSI/HI 9.6.2, 9.6.3, 9.6.4, 9.6.6, 9.6.8 and 14.1-14.3 and the requirements of this section. Select pumps that are specifically designed to pump 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.C.2 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) Not Used

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) 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 1.04.C.3 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 11002.

   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 01900. 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 11002. Provide soleplate mounting conforming to Section 11002 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 11002 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.

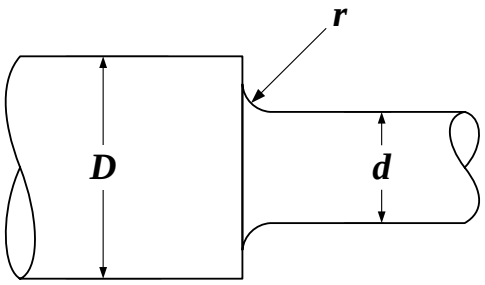
3. Torsional shaft stresses:
   a. Calculate shaft stresses using the following equation and the stress concentration factors in the tables below:

$$S = S_{cf} \times \frac{G \times D \times \Delta_{\Theta}}{2 \times L}$$

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:



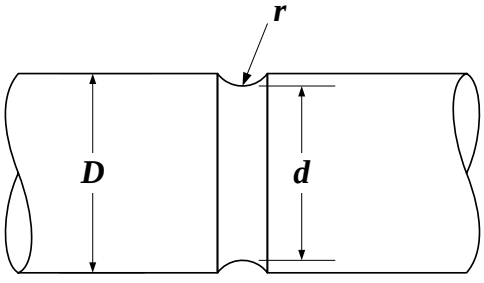
Shaft diameter ratio D/d = 1.05

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

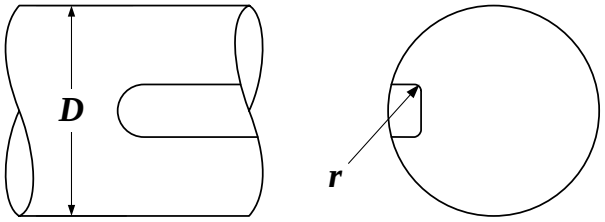
r/d	S_{cf} [a]
0.0025	4.05
0.0100	2.54
0.0200	2.07
0.0300	1.85
0.0400	1.72
0.0500	1.62
0.1000 and greater	1.40

   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

a. 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 11000.

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 11367 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.E.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 11000.

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 01300.
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 11000-1.02 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 11367. 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. Driver unit support calculations and data if the driver is separately supported.

l. 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 1.05.B.5.c

m. Detail drawings of the pump and driver unit foundation demonstrating conformance to this section and Section 11002. 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.

n. Limiting nozzle loading criteria, if different from that established by ANSI/HI 9.6.2.

o. 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 01300:
    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 01730.
    d. Motor information submittals as specified in Section 11367.
    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 11000-Form A as specified in paragraph 3.01.
    k. Training certification Section 11000-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 11005.
    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)

a. 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 11002. 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 15085 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 11002. Upon completion of installation work, the contractor shall submit a complete, properly signed certification Form 11000-A as specified in Section 01999.

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 01660. Alignment techniques shall conform to the requirements of Section 11005.

3.04 FIELD TESTING

A. Field testing shall conform to the requirements of Section 01660 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

   1. 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.

2. 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 01664 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 11000-B as specified in Section 01999.

END OF SECTION

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SECTION 11367

MULTI-STAGE VERTICAL CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies vertical multi-stage, variable speed, end suction, centrifugal pumps for the Cameron Pump Station No. 1, No. 2, and No. 3.
   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 11050 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 11000: General Requirements for Equipment
   2. Section 11020: 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

Reference	Title
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 11000, 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 11000-C, Section 01999).

1.06 SUBMITTALS

A. Action Submittals:
   1. Comply with procedures described in Section 01300.
   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 Drawings E-101, E-102, E-111, E-112, E-121, E-122, M-100, M-110 and M-120 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.

3. 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, E-102, E-111, E-112, E-121, and E-122 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 01300.
2. Show guaranteed pump performance curves.
3. Provide certification that pumping units meet vibration and critical speed limitations as specified in Section 11020.
4. Submit Installation Certification Form 11000-A as specified in paragraph 11367-3.01.
5. Submit Training Certification Form 11000-B as specified in paragraph 11367-3.03.

C. Closeout Submittals:
1. Comply with procedures described in Section 01730.
2. Provide field vibration test reports in accordance with paragraph 11050-3.06.
3. Provide operating and maintenance submittals as specified in Section 01730, including final reviewed submittal and as-built drawings.
4. Spare Parts
a. 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 11000-2.12.
1) 1-ea Pump Stack Kit
2) 1-ea O-ring/gasket kit
3) 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 11050-1.04 except when the title of the detailed section includes “Custom Engineered” in which case Section 11050-1.05 applies.

C. Vibration Limits
1. Vibration limits shall be in accordance with Section 11050-3.06 and subject to field testing in accordance with paragraph 3.04 of this section.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following candidate manufacturers are capable of producing equipment and/or products satisfying the requirements of this section. Manufacturer's 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	BPS1	BPS2	BPS3
Condition A			
Capacity, gpm	160	35	35
Total head, feet	161	95	95

a.

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	BPS1	BPS2	BPS3
Efficiency at Condition A, minimum, percent [a]	64	90	90
Piping connection size, inches, minimum	4	2	2
Inlet	4 ANSI 150	2 ANSI 350	2 ANSI 350
Discharge	4 ANSI 350	2 ANSI 350	2 ANSI 350

Pump	BPS1	BPS2	BPS3
Motor			
Horsepower	15	1.5	1.5
Type	Totally Enclosed Fan Coooled (TEFC)	Totally Enclosed Fan Coooled (TEFC)	Totally Enclosed Fan Coooled (TEFC)
Inverter duty	Yes	Yes	Yes
Space heater	No	No	No
Thermal protection	Yes	Yes	Yes
Ambient duty rating	+40 Deg. C	+40 Deg. C	+40 Deg. C
Operating speed, rpm, maximum	3.540		
Voltage rating	PS No. 1: 460 volt, 3 Phase	240 volt, 1 Phase	240 volt, 1 Phase
Efficiency	NEMA Premium	NEMA Premium	NEMA Premium
Service Factor	1.15	1.15	1.15
Motor starting type	VFD, coordinate for proper starting of driven equipment.	VFD, coordinate for proper starting of driven equipment.	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.

D. Vibration and Critical Speeds

1. The pump shall comply with the requirements of Section 11020.

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
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, Plate Steel Soleplate, Polymer Concrete Soleplate, or Corrosion Resistant FRP Baseplate].
   2. Install mounting plates per Section 11002.
   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 03600.

C. Equipment Anchors
   1. Install per Structural Drawings

D. Equipment Anchor Sleeves
   1. Install per Section 11002.
   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 11000-A as specified in Section 01999.

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 01664.
   3. Certify completion of training on Form 11000-B as specified in Section 01999.

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Navajo Nation
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

CAMERON PUMP STATIONS AND PRESSURE RELIEF VALVES

DIVISION 15

MECHANICAL

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SECTION 15010

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.
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 domestic made 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. Furnish complete catalog data for manufactured items of equipment to be used in the Work to for review within 15 days after award of Contract.

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. Submit a minimum of five copies of data in binders and index in same order and name as they appear in Specification. - Optional: Provide electronic submittals. Electronic submittals shall be in .pdf format, and shall be compiled into a single file, with bookmarks for each piece of equipment.
   1. State sizes, capacities, brand names, motor HP, electrical requirements, accessories, materials, gauges, dimensions, and other pertinent information.
   2. List on catalog covers page numbers of submitted items.
   3. Underline or highlight applicable data.

D. If material or equipment is not as specified or submittal is not complete, it will be rejected.

E. Catalog data or shop drawings for equipment which are noted as approved shall not supersede Contract Documents.

F. 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.

G. Check work described by catalog data with Contract Documents for deviations and errors.

H. 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.

I. The Contractor shall review the submittals prior to submission to make sure that the submittals are complete in all details. No submittal will be reviewed which does not bear the contractor's notation that such checking has been made.

J. No partial submittals will be considered unless approved by the Engineer.

K. Manufacturers' names shall be mentioned as acceptable prior to bidding.

L. Contractor shall verify equipment dimensions to fit the spaces provided with sufficient clearance for servicing the equipment.

M. 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.

N. 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.

O. For unacceptable items, the right shall be reserved to require the first named specified items.

P. Where submittals are sent with any of the above listed information missing or are incomplete they will be returned to the contractor unchecked to be completed and resubmitted. No additional time or money shall be allowed for failure to provide complete submittals on the first review.

Q. If an item requiring submittal review is ordered, purchased, shipped, or installed prior to the submittal review the item shall be removed from the job site and replaced with an approved item at contractors expense.

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. Painting shall be by persons experienced in painting.

B. All exposed, insulated, and bare piping, equipment, metal stands and supports shall be painted.

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 WARRANTY GUARANTEE:

A. The Contractor shall warrant all materials and equipment to be of quality consistent with specifications as represented by manufacturer's published data.

B. The Contractor shall guarantee that the installation and operation of the equipment shall be free from defects for a period of one year beginning at date of substantial completion and acceptance. The Contractor shall replace or repair any part of the installation that is found to be defective or incomplete within the guarantee period.

C. The one year guarantee on equipment and systems shall commence when equipment has been demonstrated to work and has been accepted. (Example: If an equipment item fails to perform and it takes 9 months after substantial completion to correct, then the guarantee shall commence after the item has been demonstrated to perform and has been accepted.)

D. Substantial completion and acceptance in no way relieves the Contractor from providing the systems and equipment as specified.

1.22 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.

1.23 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.

1.24 OPERATION AND MAINTENANCE MANUAL FOR MECHANICAL SYSTEMS

A. Upon completion of work and before final payment, Contractor shall furnish and deliver to the Owner, through the Engineer, installation, operation and maintenance manuals with instructions for all new materials and equipment used in the building. The contractor shall provide three (3) hard copies of the manuals, and three (3) CD's with electronic copies of the manuals. Electronic information shall be .PDF format. The CD's shall include the same information as the hard copies, and shall be organized in the same manner with electronic bookmarks for each section. CD case and the CD itself shall be labeled the same as the hard copies of the manuals.

B. Bind Operation and Maintenance Manual for Mechanical Systems in a hard-backed piano hinge loose-leaf binder with strong sturdy cover. The project name shall be on the spine and the front of the binder. The front of the binder shall include the following information:

OPERATION
AND
MAINTENANCE
MANUAL
for MECHANICAL SYSTEMS of
(Name of Project)
(Location of Project)
(Date of Project Award)
(Name of Architect)

C. Introduction

1. Title page including name of project, project number, date awarded and date of substantial completion.
2. Second page shall contain the names, phone numbers and addresses of Architect, Consulting Engineers, Mechanical Contractor, and General Contractor.
3. Third page shall include a Table of Contents for the entire manual.

D. First Section - Summary information including:

1. First page shall contain the contractor's warranties.
2. Second page shall contain a list of names, addresses and phone numbers of contractors and all sub-contractors and work to which each was assigned.

3. Final page or pages shall contain an equipment list. The list shall contain each item of equipment or material for which a submittal was required giving ID or tag no as contained on the drawings make and model No. Serial No. Identification No. Location in building, function along with the name, address, and phone number of the supplier.

E. Second Section - Mechanical Equipment O&M data including:

1. Mechanical maintenance schedule, including a lubrication list when necessary.
2. Mechanical Equipment Operation and Maintenance Data including:

    a. Equipment descriptions
    b. Detailed installation instruction, operating and maintenance instructions. Instructions include in a step by step manner identifying start-up, operating, shutdown and emergency action sequence sufficiently clear so a person unfamiliar with the equipment could perform its operations.
    c. Equipment drawings, performance curves, operating characteristics, etc.
    d. Name addresses and phone number of manufacturer, fabricator and local vender clearly printed or stamped on cover.
    e. Complete parts listing which include catalog number, serial number, contract number or other accurate provision for ordering replacement and spare parts.
    f. Certified drawings, where applicable, showing assembly of parts and general dimensions.

3. Approved Mechanical submittals

F. Third Section - Controls O&M data including:

1. Sequence of Operation
2. Description of each operating system included location of switches, breakers, thermostats, and control devices. Provide a single line diagram, showing set points, normal operating parameters for all loads, pressures, temperatures and flow check points; Describe all alarms and cautions for operation.
3. Provide schematic control diagrams, panel diagrams, wiring diagrams, etc. for each separate fan system, chilled water system, hot water system, exhaust air system, pumps, etc. Each control diagram shall show a schematic representation of mechanical equipment and location of start-stop switches, insertion thermostats, thermometers, pressure gauges, automatic valves, etc. The correct reading for each control instrument shall be marked on the diagram.

G. The Fourth Section shall contain a complete air and water test and balance report. The report shall contain the name, address and phone number of the agency. It shall also include:

1. Floor plans showing all air openings and thermometer locations clearly marked and cross referenced with data sheets. Format may be 8 1/2 x 11 or 11x14 if legible.
2. Data sheets showing amount of air and water at each setting. See sections 22 and 23.
3. List of equipment with date of last calibration.

H. Drawings and reproducible masters of drawings as required in individual specification sections, are not to be bound in volumes but are to be delivered separate with the maintenance manuals.

I. See the following checklist for assistance in assembling manual:

Item #	Description	Y, N, or NA
1.	3 ring heavy duty binder with Project name, number and date on cover and project name on spine.	
2.	O&M manual on CD (with label on CD matching label on manual). Electronic copy shall be a PDF file with bookmarks that match the tabs in the hard copy.	
3.	Title Page [including project name, number, address, date awarded, date of substantial completion]	
4.	Second Page Contact List [including architect (if applicable), mechanical engineer, mechanical contractor, and general contractor (if applicable)]	
5.	Table of Contents	
6.	Section 1 - Summary	
A.	Warranty	
B.	Mechanical's Sub-contractor List	
C.	Vendor List	
D.	Equipment List	
7.	Section 2 – Mechanical Equipment	
A.	Maintenance Schedule (including lubrication list)	
B.	Mechanical Equipment O&M Data (for each piece of equipment submitted) per specifications	
C.	Approved mechanical submittals	
8.	Section 3 - Controls	
A.	Sequence of Operation	
B.	Controls diagrams	
C.	Controls Equipment	
9.	Section 4 – Test and Balance Report	

A.	Complete Test and Balance Report per specifications	

1.25 OPERATION AND MAINTENANCE INSTRUCTIONS

A. Contractor shall instruct building maintenance personnel in the operation and maintenance of the installed mechanical systems utilizing the Operation and Maintenance Manual when so doing.

B. Minimum instruction periods shall be as follows -

1. Mechanical - Two 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 on site instruction will be provided by each contractor, after 60 days of system operation by owner to insure proper system operation and answer questions.

1.26 RECORD DRAWINGS

A. Contractor shall keep an up-to-date set of mechanical and plumbing drawings in his custody showing all changes in red, clearly defined and neatly drafted by him. At the end of construction, he shall turn these drawings over to the Engineer. Record drawings must be completed and submitted prior to final site observation

PART 2 - PRODUCTS
(Not Used)

PART 3 - EXECUTION
(Not Used)

END OF SECTION

SECTION 15050

PIPING SYSTEMS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies systems of process piping and general requirements for piping systems. Detailed specifications for the components listed on the Piping System Specification Sheets are found in other sections of Division 15. This section shall be used in conjunction with those sections.

B. DEFINITIONS:

Pressure terms used in Section 15050 and elsewhere in Division 15 are defined as follows:

1. Maximum: The greatest continuous pressure at which the piping system operates.

2. Test: The hydrostatic pressure used to determine system acceptance.

1.02 QUALITY ASSURANCE

A. REFERENCES:

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.

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 M36/M36M	Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts and Underdrains
ANSI A13.1	Scheme for the Identification of Piping Systems
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.3	Malleable Iron Threaded Fittings Class 150 and 300
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B16.9	Factory-Made Wrought Steel Buttwelding Fittings
ANSI B16.11	Forged Steel Fittings, Socket Welding and Threaded
ANSI B16.12	Cast Iron Threaded Drainage Fittings
ANSI B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ANSI B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ANSI B31.1	Power Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Qualifications
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	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A197	Cupola Malleable Iron
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A312/A312M	Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A403/A403M	Wrought Austenitic Stainless Steel Piping Fittings
ASTM A536	Ductile Iron Castings
ASTM A570/A570M	Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
ASTM B88	Seamless Copper Water Tube

Reference	Title
ASTM C76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C443-REV A	Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials
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 D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3261	Butt Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D4101	Propylene Plastic Injection and Extrusion Materials
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
AWWA C105	Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
AWWA C110	Ductile-Iron and Gray-Iron Fittings, 3 Inch Through 48 Inch, for Water and Other Liquids
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 C151	Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
AWWA C153	Ductile-Iron Compact Fittings, 3 Inches through 12 Inches, for Water and Other Liquids
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.

Reference	Title
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 C605	Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
AWWA C651	Disinfecting Water Mains
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water
AWWA C901	Polyetheylene (PE) Pressure Pipe and Tubing, ¾ In. (19 mm) Through 3 In. (76 mm), for Water Services
AWWA C906	Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 65 In. (100 mm Through 1,650 mm), for Waterworks
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
FEDSPEC L-C-530B(1)	Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy
MIL-H-13528B	Hydrochloric Acid, Inhibited, Rust Removing
MIL-STD-810C	Environmental Test Methods
SAE J1227	Assessing Cleanliness of Hydraulic Fluid Power Components and Systems
UPC	Uniform Plumbing Code
NTUA	Navajo Area Standards & Construction Requirements

B. FITTINGS AND COUPLING COMPATIBILITY:

To assure uniformity and compatibility of piping components, fittings and couplings for grooved end piping systems shall be furnished by the same manufacturers.

1.03 SUBMITTALS

Submittals and product data for all piping materials shall be provided in accordance with Section 01300.

Piping layout drawings for all piping (including encased and above ground piping) shall be transmitted to the CONSTRUCTION MANAGER a minimum of 2 weeks prior to construction. Drawings shall be original layouts by the CONTRACTOR; photocopies of contract drawings are not acceptable.

1.04 TEMPORARY ABOVEGROUND POTABLE WATER PIPE (HIGH LINE)

High line piping shall be provided where water service is to be maintained and as required by the CONSTRUCTION MANAGER. High line piping and appurtenances shall be furnished, installed, disinfected, connected, maintained, and removed by the CONTRACTOR. Bacteriological sampling and testing shall be performed by a certified testing laboratory approved by the Owner. The Contractor shall coordinate highlining activities with the Construction Manager.

PART 2--PRODUCTS

2.01 PIPING MATERIALS

Unless otherwise specified, piping materials, including pipe, gaskets, fittings, connection and joint assemblies, linings and coatings, shall be selected from those listed on the piping system specification sheets. Piping materials shall conform to detailed specifications for each type of pipe and piping appurtenance specified in other sections of Division 15.

2.02 PIPING IDENTIFICATION

A. PLASTIC CODING MARKERS:

Plastic markers for coding pipe shall conform to ANSI A13.1 and shall be as manufactured by W. H. Brady Company, Seton Name Plate Corporation, Marking Services Inc., or equal. Markers shall be the mechanically attached type that are easily removable; they shall not be the adhesive applied type. Markers shall consist of pressure sensitive legends applied to plastic backing which is strapped or otherwise mechanically attached to the pipe. Legend and backing shall be resistant to petroleum based oils and grease and shall meet criteria for humidity, solar radiation, rain, salt, fog and leakage fungus, as specified by MIL-STD-810C. Markers shall withstand a continuous operating temperature range of -40 degrees F to 180 degrees F. Plastic coding markers shall not be the individual letter type but shall be manufactured and applied in one continuous length of plastic.

Markers bearing the legends on the background colors specified in the PIPESPEC shall be provided in the following letter heights:

Outside pipe diameter,[a] inches	Letter height, inches
Less than 1-1/2	1/2
1-1/2 through 3	1-1/8
Greater than 3	2-1/4

[a] Outside pipe diameter shall include insulation and jacketing.

In addition, pipe markers shall include uni- and bi-directional arrows in the same sizes as the legend. Legends and arrows shall be white on blue or red backgrounds and black on other specified backgrounds.

B. MAGNETIC TRACER TAPE:

Polyethylene magnetic tracer tape shall be as manufactured by Allen Systems, W. H. Brady Co., Seton Name Plate Corporation, Marking Services Inc., or equal. Tape shall be acid and alkali-resistant, 3 inches wide, 0.005 inch thick, and have 1500 psi strength and 140 percent elongation value. The tape shall be colored the same as the background colors as specified in paragraph 15050-3.06 and shall be inscribed with the word "CAUTION--PIPE BURIED BELOW" and the name of the piping system.

2.03 VALVES

Valves of the same size and service shall be provided by a single valve manufacturer. Packing shall be nonasbestos material. Actual length of valves shall be within 1/16 inch (plus or minus) of the manufacturer's specified length. Flanges shall meet the requirement of ANSI B16.5. Push-on and mechanical joints shall meet the requirements of AWWA C111. Manual Valve operators are specified in Sections 15184. Motorized Valve operators are specified in Section 11830.

PART 3--EXECUTION

3.01 INSTALLATION

A. LOCATION:

Piping shall be provided as specified except for adjustments to avoid architectural and structural features and shall be coordinated with electrical construction.

B. PIPING SIZES:

Where the size of piping is not specified, the CONTRACTOR shall provide piping of the sizes required by UPC. Unless specified otherwise, small piping (less than 1 inch in diameter) required for services not described by UPC shall be 1/2 inch.

C. PIPE SUPPORT, ANCHORAGE AND SEISMIC BRACING:

1. GENERAL: Piping shall be supported by anchor brackets, guides, saddles or hangers. Acceptable types of supports, guides, saddles, hangers and structure attachments for general pipe support, expansion/ contraction and for seismic bracing, as well as anchorage details, are shown on the drawings. Minimum spacing shall be as specified for supports and for seismic bracing. Where a specific type of support or anchorage is indicated on the drawings, then only that type shall be used there. Piping shall be vertically supported by anchor brackets, guides, saddles or hangers and shall be seismically braced where indicated to resist lateral load. Supports shall be provided on each run at each change of direction. Pipe supports shall be hot-dip or mechanically galvanized. Unless otherwise specified, existing pipes and supports shall not be used to support new piping.

2. PIPING CONNECTIONS TO MACHINES: Piping at machine connections shall be aligned 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. Bolts shall not be forced into mating flange bolt holes and shall be capable being withdrawn using finger pressure alone. The use of 'dutchmen' mitered sections or similar specials to achieve the required alignment with machine connections is strictly prohibited.

D. ANCHORAGE FOR BURIED PIPING:

All plugs, caps, tees and bends in buried pressure piping systems shall be anchored by means of reaction backing or restrained joints as specified.

E. BEDDING AND BACKFILL:

Bedding and backfill for buried piping shall be as specified.

F. EQUIPMENT CONNECTION FITTINGS

Where shown, equipment connection fittings as specified in Section 15085 shall be provided between field piping systems and equipment inlet and outlet connections.

G. FLEXIBILITY

Pipe couplings or flexible joints shall be provided as specified.

Unless otherwise specified, piping passing from concrete to earth shall be provided with two pipe couplings or flexible joints as specified in Section 15085.

3.02 PIPING IDENTIFICATION

A. PIPE CODING:

After application of the specified coating and insulation systems, exposed piping, interior and exterior, and piping in ceiling spaces, pipe trenches, pipe chases and valve boxes shall be identified with plastic markers as specified in paragraph 15050-2.02 A. Legend markers and directional arrows shall be located at each side of walls, floors and ceilings, at one side of each piece of equipment, at piping intersections, and at approximately 50-foot centers.

B. MAGNETIC TRACER TAPE:

Polyethylene magnetic tracer tape shall be buried 12 to 18 inches below ground and shall be above and parallel to buried nonferrous, plastic and reinforced thermosetting resin pipelines. For pipelines buried 8 feet or greater below final grade, the CONTRACTOR shall provide a second line of tape 2.5 feet above and parallel to the buried pipe.

3.03 VALVE IDENTIFICATION

Stainless steel tags bearing the specified valve number stamped in 1/4-inch high letters shall be installed on valve flanges in a position visible from floor level. Flangeless valves 8 inches in diameter and larger shall have tags attached to the valve body by self-tapping corrosion resistant metal screws. Flangeless valves 6 inches in diameter and smaller shall have tags attached to the valve stem by stainless steel wire. Wire shall be 0.063 inch minimum.

3.04 TESTING

A. GENERAL:

Upon completion of piping, but prior to application of insulation on exposed piping, the CONTRACTOR shall test the piping systems. Pressures, media and test durations shall be as specified in Paragraph 3.09 of the Navajo Area Standards & Construction Requirements (See Appendix G) and paragraph 3.06 15050. Equipment which may be damaged by the specified test conditions shall be as specified Testing shall be performed using calibrated test gages and calibrated volumetric measuring equipment to determine leakage rates. Each test gage shall be selected so that the specified test pressure falls within the upper half of the gage's range. Unless otherwise specified, the CONTRACTOR shall notify the CONSTRUCTION MANAGER 24 hours prior to each test.

Unless otherwise specified, testing, as specified herein, shall include existing piping systems which connect with new pipe systems. Existing pipe shall be tested to the nearest existing valve. Any piping which fails the test shall be repaired. Repair of existing piping will be considered and paid for as extra work.

B. GAS, AIR, AND VAPOR SYSTEMS: (NOT USED)

C. LIQUID SYSTEMS: (NOT USED)

D. HYDRAULIC AND LUBE OIL SYSTEMS: (NOT USED)

E. DRAINS:

Drain systems, other than pumped drain systems, shall be tested in accordance with UPC and the local governing agency.

F. GRAVITY SEWER LINES: NOT USED

3.05 CLEANING AND FLUSHING

A. GENERAL:

Piping systems shall be cleaned following completion of testing and prior to connection to operating, control, regulating or instrumentation equipment. The CONTRACTOR may, at his option, clean and test sections of buried or exposed piping systems. Use of this procedure, however, will not waive the requirement for a full pressure test of the completed system. Unless specified otherwise, piping 24 inches in diameter and smaller shall first be cleaned by pulling a tightly fitting cleaning ball or swab through the system. Piping larger than 24 inches in diameter may be cleaned manually or with a cleaning ball or swab.

B. TEMPORARY SCREENS:

Upon completion of the cleaning, the CONTRACTOR shall connect the piping systems to related process equipment. Temporary screens, provided with locator tabs which remain visible from the outside when the screens are in place, shall be inserted in pipelines at the suction of pumps and compressors in accordance with the following table:

Equipment suction or piping size, inches	Maximum screen opening, inches
0 –1	1/16
1-1/4 – 3	1/4
3-1/2 – 6	1/2
Over 6	1

The CONTRACTOR shall maintain the screens during testing, initial start-up, and initial operating phases of the commissioning process. In special cases, screens may be removed as required for performance tests. The CONTRACTOR shall remove the temporary screens and make the final piping connections after the screens have remained clean for at least 24 consecutive hours of operation. Systems handling solids are exempted.

C. GAS AND AIR SYSTEMS: NOT USED

D. LIQUID SYSTEMS: NOT USED

E. CHLORINE SYSTEMS: NOT USED

F. STEAM SYSTEMS: NOT USED

G. HYDRAULIC AND FLUID POWER OIL SYSTEMS: NOT USED

H. POTABLE WATER SYSTEMS:

Potable water piping systems shall be flushed, tested and disinfected in accordance with NTUA requirements. Furnish test equipment, chemicals for chlorination, temporary valves, bulkheads and other water equipment control equipment and materials required. A Water Use Permit is required to obtain water for flushing. Coordinate water use permit with Navajo Nation Department of Water Resources (DWR) Technical, Construction and Operations Branch (TCOB) and NTUA – See Water Use Permit Application in Appendix G.

Indiscriminate onsite disposal or discharge of chlorinated water to sewer systems, storm drains, drainage courses or surface waters is prohibited.

Pipes, fittings, valves and all other components incorporated into tie-ins and connections with the existing system shall be spray disinfected or swabbed with a liquid chlorine solution in accordance with Hydrostatic Pressure Testing and Disinfection of Water Mains (see Appendix G) and AWWA C651 and as specified herein. Upon connection to the main, the line shall be flushed as directed by the CONSTRUCTION MANAGER. Disinfection by this method is generally limited to assemblies of 20' or less in length. Alternate methods such as "predisinfection" prior to installation in accordance with AWWA C651 may be required at the discretion of the CONSTRUCTION MANAGER.

3.06 PIPING SPECIFICATION SHEETS (PIPESPEC)

Piping and valves for groupings of similar plant processes or types of service lines are specified on individual piping specification sheets (PIPESPECS). Piping services are grouped according to the chemical and physical properties of the fluid conveyed and/or by the temperature or pressure requirements. Each grouping of services (PIPESPEC) is identified by a piping system number. Piping services specified in the PIPESPECS are designated by service symbols as shown in Table A. Table A also indicates the system number, fluid category, and pipe marker background color of each service.

Table A, Piping Services

Symbol	Service	System	Fluid category	Pipe marker color[1]

Symbol	Service	System	Fluid category	Pipe marker color[1]
D	Drain	24	Drain/Vent	Green
OF	Over Flow	24	Drain/Vent	Green
1W	Potable Water (City water)	7	Water	Blue
2W	Potable Water (downstream of air gap or backflow preventer)	7	Water	Blue

3.06 PIPING SPECIFICATION SHEET--PIPESPEC

Piping Symbol/Service 1W--Potable Water System--7
2W—Potable Water (downstream of air gap or backflow preventer)

Test Requirements:
- Medium: Water; ref. spec paragraph 15050-3.04 C.
- Pressure: 200 psig (see Hydrostatic Test Pressure & Disinfection Requirements – Appendix G)
- Duration: 120 minutes

Gasket Requirements:
- Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
- Push-on/Mech Cpl: EPDM

Exposed Pipe and Valves:
(See IHS/NTUA Standard Drawings for pipe size and valve type.)

(3" and smaller)
- Pipe: Copper tube; ASTM B88, Type L, drawn.
  Conn; solder type with threaded or flanged adapters for valves.
  Ftgs; wrought copper or bronze, ANSI B16.22.
  Insulation: See Remarks

  PVC; ASTM D1784, Class 12454 B, NSF certified, ASTM D1785, Sch. 80. Ref. spec Section 15064.
  Conn; plain end; solvent weld.
  Ftgs; PVC, Sch. 80, socket type.
- Valves: Ball; Jamesbury Fig. 351, Nibco T-580, or equal.
  Globe; Crane 7TF or 17TF, Lunkenheimer 123 or 214, or equal.

Ball; PVC, true union, socket type, Chemtrol Tru Block TU Series, Asahi/ America Duo Bloc TU Series, GSR TU Series, or equal, with PTFE seats and Viton O-rings.
Diaphragm; PVC body, PTFE diaphragm, Chemtrol Series PD, Posacon 677, Asahi/ America, or equal.

Gate;

Butterfly;

Pressure Reducing

Hose Bib

Swing Check;

(4" and larger)
Pipe: Ductile iron; AWWA C151 with NSF Compliant lining and coating. Polyethylene encasement per ANSI/AWWA A21.5/C105.
Conn; Restrained mechanical joint pipe. Flanged adapters for valves.
Ftgs; ductile iron; restrained mechanical joint, coating, lining, and ends to match pipe.

(3" and larger)
Valves: Pressure Reducing; Ref. spec Section 15153.

Butterfly; Ref. spec Section 15103. Substitute Type B on 2-1/2-inch lines.

Swing Check

Buried Pipe and Valves:
(See drawings for pipe size and valve type.)

(4" to 12")
Pipe: HDPE; per AWWA C901

PVC; per AWWA C900, DR as specified. Ref. spec Section 15064.
Restrained push-on rubber gasket joint. Flanged adapters for valves and fittings.
Ftgs; ductile iron; coating, lining and ends to match pipe.

	Ductile iron; AWWA C151 with NSF Compliant lining and coating. Polyethylene encasement per ANSI/AWWA A21.5/C105. Ref, spec Section 15062. Conn; Restrained mechanical joint pipe. Flanged adapters for valves. Ftgs; ductile iron; restrained mechanical joint, coating, lining, and ends to match pipe.
Valves:	Gate; Resilient Seated. ref. spec Section 15102, with extension stem and valve box.

Remarks:

1. Sleeves shall be installed of proper size for all pipes passing through walls as shown on the drawings. Where indicated on the drawings, or required for liquid or gas-tightness, the pipe shall be sealed with mechanical seal by Link Seal as manufactured by Thunderline Corp., Wayne, Michigan, or equal.

2. All pipe and appurtenances connected to equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment.

3. System 7 piping installed in areas and locations subject to freezing (including ceiling areas which are not heated) shall be insulated.

4. Water lines installed over suspended or other type ceilings shall be insulated for condensation control.

5. Systems shall be disinfected per NTUA Testing and Disinfecting Water Mains – See Appendix G.

6. 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 weather board overlap.

   Smooth contours shall have a minimum thickness of 50 mils while nuts, bolts, and sharp projections shall be 100 mils.

3.06 PIPING SPECIFICATION SHEETS--PIPESPEC

Piping Symbol/Service:	D--Drain STD--Storm Drain V--Vent	System--24

Test Requirements:

Medium:	In accordance with Section 712, Uniform Plumbing Code.
Pressure:	In accordance with Section 712, Uniform Plumbing Code.
Duration:	In accordance with Section 712, Uniform Plumbing Code.

Gasket Requirements:

Flange:	Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push-on/Mech Cpl:	Nitrile or neoprene

Exposed Pipe and Valves:
(See drawings for pipe size.)

(3" and smaller)

Pipe:	None
Valves:	None

(4" thru 12")

Pipe:	None
Valves:	None

Buried and Encased Pipe and Valves Under and 5 Feet Outside Building
(See drawings for pipe size.)

(12" and smaller)

Pipe:	None
Valves:	None

Buried and Encased Pipe and Valves Beyond 5 Feet Outside Building
(See drawings for pipe size.)

(3" and smaller)

Pipe:	None
Valves:	None

(4” thru 12")

Pipe: HDPE; per AWWA C906

Valves: None

Remarks:

1. None

END OF SECTION

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SECTION 15058

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 15062

DUCTILE IRON PIPE

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies ductile iron pipe, ductile fittings and gaskets.

B. DEFINITION:

Where cast iron pipe is specified, the term and symbol shall mean ductile iron pipe.

1.02 REFERENCES

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.

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

Reference	Title
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
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
NTUA	Navajo Area Standards & Construction Requirements

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

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. Shop fabrication drawings showing details of materials, piping, fittings, couplings, dielectric connections, joint locations and details, types and locations of supports.

3. CONTRACTOR's layout drawings as specified in paragraph 15050-1.03.

4. Certifications specified in the following documents:

   ANSI A21.14, paragraph 14-4.2
   ANSI A21.52, paragraph 52-4.2
   ASTM A716, paragraph 4.2
   AWWA C110, paragraph 10-5.3
   AWWA C111, paragraph 11-7.1
   AWWA C115, paragraph 15-4.2
   AWWA C151, paragraph 51-5.2
   AWWA C153, paragraph 53-6.3
   AWWA C606, paragraph 4.1.1.1

5. Other data necessary to show conformance of the complete piping system to these specifications.

PART 2--PRODUCTS

2.01 GENERAL

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

Item	Document
Cement mortar lining	AWWA C104

2.02 PIPE

Unless otherwise specified, ductile iron pipe shall be Class 50 and have nominal laying lengths of 18 or 20 feet. For grooved-end pipe, wall thickness shall be minimum Class 53 except where the specified pressure requires heavier pipe.

2.03 GASKETS

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

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 paragraph 15050-1.02 B.

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 15062-2.03 and 2.05 D, 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 15062-2.05 A.1., 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.

Unless otherwise specified, bolts and nuts for flange assemblies shall conform with paragraph 15085-2.01 C. Gaskets shall be as specified in paragraph 15085-2.01 B.

4. MECHANICAL JOINTS: Where specified, restrained mechanical joints shall be the positive restraint type. Mechanical joints with retainer glands are not acceptable.

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

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)

PART 3--EXECUTION

3.01 INSTALLATION

A. GENERAL:

Piping runs specified on the drawings shall be followed as closely as possible. Proposed deviations shall be submitted in accordance with Section 01300.

Pipe shall be installed in accordance with AWWA C600.

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:

Where a metallic nonferrous pipe or appurtenance is connected to ferrous pipe or appurtenance, an insulating section shall be provided as specified in paragraph 15085-3.05.

C. ANCHORAGE:

Anchorage shall be provided as specified. Calculations and drawings for proposed alternative anchorage shall be submitted in accordance with Section 01300.

3.02 ACCEPTANCE TESTING

Hydrostatic pressure tests shall be conducted in accordance with AWWA C600, Paragraph 3.09 of the Navajo Area Standards & Construction Requirements (See Appendix H), and at test pressures listed in Section 15050.

The CONTRACTOR shall conduct the tests in the presence of the CONSTRUCTION MANAGER.

END OF SECTION

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SECTION 15064

PLASTIC PIPE

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies polyvinylchloride, chlorinated polyvinylchloride, polyethylene, and polypropylene pipe and fittings. High density polyethylene (HDPE) piping for trenchless installation shall be per specification Section 15065.

The Contractor shall provide all necessary labor, materials, appurtenances, equipment, and services for a complete, in-place pipeline.

B. PIPE DESIGNATIONS:

For use in the Piping System Specification Sheets (PIPESPEC) in Section 15050 and in this section, the following plastic pipe designations are defined:

Designation	Definition
PVC	Polyvinylchloride
CPVC	Chlorinated polyvinylchloride
PE	Polyethylene
PP	Polypropylene

1.02 QUALITY ASSURANCE

A. REFERENCES:

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.

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 D1248	Polyethylene Plastics Molding and Extrusion Materials
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 D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
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 D2657	Heat-Joining Polyolefin Pipe and Fittings
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D4101	Propylene Plastic Injection and Extrusion Materials
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

Reference	Title
AWWA C110	Ductile-Iron and Gray-Iron Fittings
AWWA C111	Rubber-Gasket Joints for Ductile-Iron
AWWA C115	Flanged Ductile-Iron Pipe With Ductile-Iron
AWWA C116	Protective Fusion-Bonded Epoxy Coatings
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast
AWWA C153	Mechanical Joint Ductile Iron Fittings
AWWA C210	Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings
AWWA C605	Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings
AWWA M23	PVC Pipe Design and Installation
NTUA	Navajo Area Standards & Construction Requirements

B. MANUFACTURER INSPECTION AND TESTS:

1. Unless otherwise specified, all pipe manufacturing materials, pipe and fittings provided shall be tested in accordance with the applicable referenced standards.

   a. Perform material tests at no additional cost to the Owner.

   b. In addition to those tests specifically required, Construction Manager may request additional samples of any material for testing by Construction Manager. Additional samples and testing shall be furnished at no additional cost to Owner.

2. Like pipe and fittings provided shall be furnished by a single manufacturer.

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

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. Shop fabrication drawings showing details of materials, piping, fittings, couplings, mechanical restraint devices, dielectric connections, joint locations and details, types and locations of supports.

3. CONTRACTOR's layout drawings as specified in paragraph 15050-1.03. Contractor shall provide restraint calculations including required length for mechanical restraint, placement and/or sizing of thrust blocks, based on provided layout and Section 3.03. Calculations shall be stamped by a Registered Professional Engineer in the State of Arizona.

4. Manufacturer's certificates of compliance with the specified standards.

5. Procedures for safe handling, transport and storage of HDPE piping, including maximum pipe stacking height to maintain the round pipe shape.

6. Other data necessary to show conformance of the complete piping system to these specifications.

PART 2--PRODUCTS

2.01 PVC PIPE

A. PRESSURE PIPE:

PVC material for pipe and fittings shall conform to ASTM D1784, Class 12454-B with an established hydrostatic design basis (HDB) equal to or greater than 4000 psi at 73.4 degrees F.

Pressure pipe for water lines 4 through 60-inches shall be manufactured in accordance with AWWA C900. Minimum Dimension ratio shall be as specified on the plans. Where not specified on plans, use DR18.

Where specified, pipe and fittings shall be in accordance with ASTM D1785 or shall conform to ASTM D2241 for standard dimension ratios: 160 psi pipe--SDR 26; 200 psi pipe--SDR

21; 250 psi--SDR 17. Pressure rating for pipe shall be in excess of test pressure specified in Section 15050. Neoprene gaskets with push-on joints shall conform to ASTM F477.

Where specified, Schedule 80 PVC socket type fittings shall conform to ASTM D2467. Schedule 40 PVC fittings shall conform to ASTM D2466. PVC solvent weld cement for socket connections shall meet the requirements of ASTM D2564. Schedule 80 PVC threaded fittings shall conform to ASTM D2464. Fittings for gasketed pipe shall be ductile iron or steel push-on IPS-sized pressure fittings rated for use with the specified class of PVC pipe. Unless otherwise specified, fittings shall be lined and coated in accordance with Section 15062.

B. NONPRESSURE PIPE:

1. GRAVITY SEWER PIPE: PVC material for sewer pipe and fittings shall conform to Class 12454-B, as defined in ASTM D1784. Pipe and fittings shall meet the requirements of ASTM D3034 for SDR 35. Neoprene gaskets with push-on joints shall conform to ASTM F477.

3. DRAIN, WASTE AND VENT PIPE: PVC material for drain waste and vent (DWV) pipe and fittings shall conform to Class 12454-B, ASTM D1784. Pipe and fittings shall conform to ASTM D2665. Unless otherwise specified, connections shall be solvent weld. Connections to traps, closet flanges, and nonplastic pipe shall be with approved adapter type fittings designed for intended use. Solvent weld cement for socket connections shall meet requirements of ASTM D2564.

C. FITTINGS FOR PVC PRESSURE PIPE

Fittings for PVC water lines shall be ductile-iron conforming to AWWA C110 or AWWA C153 with a minimum rated working pressure greater or equal to the provided pressure pipe. The fittings shall have restrained mechanical or push on joints manufactured specifically for the PVC pipe to be used with the fitting. Fittings with repaired defects are not acceptable and will be rejected.

Bolts and nuts for mechanical joints, or flanged ends will be of high strength corrosion resistant low-alloy steel and shall conform to AWWA C111. Flange bolts and nuts for above ground installation shall conform to Appendix A of AWWA C115. Flange bolts and nuts for below ground installation shall be 316 stainless steel. All fittings shall be fusion bonded epoxy lined and coated and lined unless stainless steel is used.

Couplings shall meet the requirements of AWWA C900 and/or C905 as applicable, and be suitable for the working pressure. Deflection shall not exceed 50% of the manufacturer's written maximum recommendation unless otherwise specified.

2.02 CPVC PIPE

CPVC material for pipe and fittings shall conform to ASTM D1784, Class 23447-B. Pipe and fittings shall be in accordance with ASTM F441. Neoprene gaskets with push-on joints shall conform to ASTM F477.

Schedule 80 CPVC socket type fittings shall conform to ASTM F439. Schedule 40 CPVC socket type fittings shall conform to ASTM F438. CPVC solvent weld cement for socket connections shall meet the requirements of ASTM F493. Schedule 80 CPVC threaded type fittings shall conform to ASTM F437.

2.03 PE PIPE

PE pipe shall meet the requirements of ASTM D1248, Type III, Grade P 34, Class C, 100 psi or as specified in Section 15050, whichever is higher. Fittings shall be of the same material, molded socket fusion for sizes 4 inch diameter and smaller and molded or fabricated butt fusion for sizes 6 inch and larger. Fittings shall be 125 psi or as specified in Section 15050, whichever is higher. Heat fusion welding shall be in conformance with ASTM D2657.

2.04 PP PIPE

A. PRESSURE PIPE:

PP pipe and fittings shall be formulated of polypropylene conforming to ASTM D4101, SDR 11, butt fusion type. Pipe shall be 150 psi rated in all sizes. Heat fusion welding shall be in conformance with manufacturer's recommendation.

B. DRAIN, WASTE AND VENT PIPE:

PP drain, waste and vent (DWV) pipe and fittings shall be made from flame retardant, Schedule 40, polypropylene (PPFR) plastic as defined in ASTM D4101. Pipe and fittings used for buried piping and in concealed locations shall be joined by electrical fusion coils energized by a variable low-voltage power supply to completely fuse the interface between the pipe and socket and form a completely homogenous structure. Unless otherwise specified, mechanical joint fittings may be used under bench or in exposed locations where future disassembly is desired. The mechanical method shall be in conformance with the manufacturer's recommendation.

PART 3--EXECUTION

3.01 STORAGE AND HANDLING

Pipe shall be stored and handled in accordance with AWWA M23 and the manufacturer’s recommendations. PVC pipe that has been gouged, scratched, or otherwise damaged shall be subject to rejection at the discretion of the Construction Manager. Rejected pipe shall be removed from the site and replaced at no additional cost to the Owner.

Cover stored PVC pipe with an opaque material to protect it from the sun's ultraviolet radiation. PVC pipe that has been subjected to excess ultraviolet radiation as identified by color fading or chalking shall not be used. The determination as to the acceptability of PVC pipe shall rest solely with the Construction Manager.

PVC pipe that has been contaminated in any way with petroleum products (on the inside or outside of the pipe) shall not be used.

3.02 INSTALLATION

PVC pipe 3 inches in diameter and smaller shall be joined by means of socket fittings and solvent welding in conformance with ASTM F402. Solvent-cemented joints shall be made in strict compliance with the manufacturer's/supplier's instructions and recommended procedures. Unless otherwise specified, PVC pipe 4 inches in diameter and greater shall be joined by means of gasketed push-on joints and steel or ductile iron push-on or mechanical joint fittings. Fittings that are not plastic or stainless steel shall be lined and coated. Linings shall meet or exceed AWWA C-116 or AWWA C-210 and fully compliant with NSF requirements for potable water service, Ceramapure PL90 ceramic epoxy, or equal. Coatings shall be asphaltic material as specified in AWWA C151. Unless otherwise specified, PVC and CPVC piping exposed to sunlight shall be painted with an approved Latex coatings Tnemec Series 1028 or 1029, Sherwin Williams, Sher Cryl HPA, or equal.

Connections to different types of pipe shall be by means of flanges, specified adapters or transition fittings. Where sleeve type couplings are used, both shall be uniformly torqued in accordance with pipe manufacturer's recommendation. Foreign material shall be removed from the pipe interior prior to assembly.

Unless otherwise specified, PE pipe and fittings 4 inch diameter and smaller shall be joined by means of thermal socket fusion and pipe 6 inch and larger by thermal butt fusion. Butt-fusion joining of the pipes and fittings shall be performed with special joining equipment in accordance with procedures recommended by pipe manufacturer. Tensile strength at yield of butt-fusion joints shall not be less than pipe. Flanged adapters shall be provided for connection to valves and where specified.

3.03 SUPPORTS, THRUST AND ANCHOR BOLTS

All plugs, caps, tees and horizontal and vertical alignment changes greater than or equal to 11 ¼ degrees and as specified in buried pressure piping systems shall be anchored by means of reaction backing thrust blocks or mechanically restrained joints.

Concrete support blocks shall be provided for all ductile-iron fittings and valves to prevent the fitting or valve weight from being carried by the PVC pipe.

3.04 TESTING

Testing of plastic piping shall be in accordance with the NTUA Standards, AWWA C651, and as specified in Section 15050.

END OF SECTION

SECTION 15065

HIGH DENSITY POLYETHYLENE (HDPE) PIPE

PART 1 -- GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies high density polyethylene (HDPE) pipe, fittings, and appurtenances for piping 2 inches to 10 inches in nominal diameter.

B. CHARACTERISTICS:

Provided HDPE pipe shall conform to the following minimum requirements:

Dimension Ratio (DR)	17
Material Designation	PE-4710
Pipe Sizing System per AWWA C906 & ASTM F714	DPS
Pressure Class in accordance with AWWA C906	125 psig

C. REFERENCES:

The publications listed below form part of this specification to the extent referenced and are referred to in the text by the basic designation only. References shall be made to the latest edition of said standards unless otherwise called for.

References	Title
ANSI/AWWA C906	Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 65 In. (100 mm Through 1,650 mm), for Waterworks
ASTM D2321	Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2657	Heat Joining Polyolefin Pipe and Fittings
ASTM D3350	Polyethylene Plastics Pipe and Fittings Material
PPI TR 31	Underground Installation of Polyolefin Piping

1.02 QUALITY ASSURANCE

A. INSPECTION AND TESTING:

All HDPE materials, pipe and fittings shall be inspected and tested in accordance with the requirements of AWWA C906.

B. AFFIDAVIT OF COMPLIANCE:

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.

1.03 SUBMITTALS

Submittals shall be in accordance with Section 01300.

Submit the following prior to commencement of the Work:

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 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. Detail drawings which show the type and location of all fittings, joints, and connections to other pipe materials.

C. Design calculations demonstrating that the pipe is capable of sustaining service conditions and the maximum loads to be imposed during installation.

D. Affidavit of Compliance specified in paragraph 15065 1.02 C.

E. A report containing a copy of all manufacturer's test results for all tests conducted in accordance with paragraph 15065-1.02 B.

1.04 DESIGN REQUIREMENTS

The design and layout of pipe shall meet the service and installation conditions and the criteria specified in this Section and as shown on the Plans are the responsibility of the Contractor. This design shall be performed by or under the supervision of a Professional Engineer licensed by the State of Arizona. The Contractor shall submit design calculations for pipe with wall thickness and pressure class demonstrating that the pipe is capable of sustaining the maximum stresses to be imposed during installation and service.

The calculations shall take into account ground loads, live loads such as traffic and railroad, and any other installation loads which may be reasonably anticipated.

PART 2 -- PRODUCTS

2.01 GENERAL

The color of the pipe shall be black with a green stripe designating drainwater.

2.02 MATERIALS

HDPE piping components shall as a minimum be manufactured from materials that meet or exceed the requirements of the Plastic Piping Institute designation PE 4710 and that conform to the requirements of ASTM D3350 for a cell classification of PE 445474C.

2.03 PIPE

Pipe shall have the nominal pipe diameter shown, with the inside diameter based on the DR and pipe sizing system shown. Dimensions and tolerances shall be as specified in AWWA C906.

2.04 FITTINGS

Fittings shall meet the pressure requirements of the specified pipe. Fittings shall conform to the applicable requirements of AWWA C906 for the joining methods specified in paragraph 15065-3.02 B.

Increase wall thickness to next nominal pressure rating/next lower DR for mitered bends. Mitered bends shall be segmented according to the following table:

Degree of bend	Minimum number of miter segments
45 or less	2
Greater than 45	4

2.05 FLANGE ENDS:

Flange End assemblies shall consist of HDPE stub end flange adapter and back up ring.

Furnish beveled flange adapters for disk clearance on connections to butterfly valves.

Stub end flange adapters shall be furnished with concentric ring convolutions on the flange face and radiuses or chamfered outer diameter transition form pipe wall to stub end.

Back up ring shall be ductile iron encapsulated in polypropylene for non corrosive applications or 316L stainless steel for corrosive applications as called for on the Plans. Drilled for ANSI B 16.5, Class 150 or AWWA C207. Flange ring bore shall be chamfered or radiuses to match transition on stub end flange adapter. Improved Piping products - PPDI, or approved equal.

2.06. BOLTS:

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.

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 BIB1.1, standard coarse thread series; bolts shall be Class 2A, nuts shall be Class 2B. Bolt length shall conform to ANSI B16.5.

PART 3 -- EXECUTION

3.01 PIPE HANDLING AND STORAGE

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.

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:

Unless otherwise specified, the piping system shall be installed in accordance with ASTM D2321, ASTM F1962, AWWA C906 and the manufacturer's recommendations.

B. JOINING:

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.

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.

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.

Internal beads formed at joints during butt fusion shall be removed from pipes that convey solids-bearing liquids. Joints shall be debeaded on all buried pipes where the beading interferes with the deflection testing specified in paragraph 15065-3.03.C

C. TRENCH EXCAVATION:

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:

Pipe and fittings shall be placed in the trench with the invert conforming to the elevations, slopes, and alignments shown.

E. BEDDING AND BACKFILL:

Materials used for bedding and backfill shall be as specified in Section 02200 and as shown.

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.

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. HYDROSTATIC PRESSURE TESTING:

HDPE piping systems shall be fully pressure tested prior to placing the line into service. Water shall be the test medium for hydrostatically testing the pipe. Test procedures shall be conducted in accordance with Paragraph 3.09 of the Navajo Area Standards & Construction Requirements (See Appendix G), and at pressures listed in Section 15050. In case of conflict, the following procedures shall apply.

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.

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 15050. 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.

B. 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 15065-1.01 B. 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 15065-1.01 B. 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 15065-1.01 B 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 **

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SECTION 15073

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.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated.

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.

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. Fans, blowers, primary balancing dampers, and mixing boxes.
2. 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. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
c. Fans, blowers, primary balancing dampers, and mixing boxes.
d. Packaged HVAC central-station and zone-type units.

C. Install access panel markers with screws on equipment access panels.

3.03 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.04 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION

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SECTION 15074

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 15074

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SECTION 15075

JOINT GASKETS

PART 1--GENERAL

1.01 DESCRIPTION

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:

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.

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 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:

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 15075-2.02 shall be provided as product data.

1.03 SUBMITTALS

Manufacturer's product data shall be provided in accordance with Section 01300.

In accordance with Section 01300, the CONTRACTOR shall provide certified copies of test reports specified in paragraph 15075-1.02 B.

PART 2--PRODUCTS

2.01 MATERIALS

Gasket stock shall be a synthetic rubber compound in which the elastomer is neoprene. The compound shall contain no less than 50 percent by volume neoprene and shall be free from factice, reclaimed rubber and other deleterious substances.

2.02 PHYSICAL REQUIREMENTS

The compound shall meet the following physical requirements when tested in accordance with the specified ASTM standards.

A. TENSILE (ASTM D412):

The tensile strength shall be 1500 psi minimum and the ultimate elongation shall be 350 percent minimum.

B. HARDNESS (ASTM D2240, TYPE A DUROMETER):

The compound shall have a hardness in the range of 35 to 50 for concrete spigots and 50 to 65 for steel spigots.

C. COMPRESSION SET (ASTM D395):

The compression set shall not exceed 20 percent when compressed for 22 hours at 70 degrees C.

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.

D. AGING (ASTM D573):

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.

E. EFFECT OF LIQUIDS (ASTM D471):

The maximum volume change in oil and in water shall be as follows:

1. Oil: 100 percent in ASTM oil No. 3.

2. Water: 15 percent.

The test specimens shall have a thickness of 0.080 $\pm$0.005 inches and shall be circular discs cut from the gasket.

F. OZONE CRACKING (ASTM D1149):

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.

PART 3--EXECUTION

The gaskets shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

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SECTION 15085

PIPING CONNECTIONS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies the following methods of connecting metallic piping: flanges, threading, mechanical couplings, equipment connection fittings, dielectric unions, and welding.

1.02 REFERENCES

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.

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

Reference	Title
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.
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

In addition to the material listed in the detailed specification, the following submittals shall be provided in accordance with Section 01300:

1. For Equipment Connection Fittings used in pumping applications submit thrust rod stretch calculations in accordance with paragraph 2.01D. 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 15050 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:

Gasket material shall be as specified in paragraph 15085-2.03.

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:

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.

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:

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.

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.

Gaskets shall be as specified in paragraph 15085-2.03 and AWWA C111.

B. PLAIN END COUPLINGS:

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.

Gaskets shall be as specified in paragraph 15085-2.03 and AWWA C606.

C. GROOVED END COUPLINGS:

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 lightwall pipe.

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.

Gaskets shall be as specified in paragraph 15085-2.03 and AWWA C 606.

D. EQUIPMENT CONNECTION FITTINGS

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.

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.

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.

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 15085-2.03. Flange gaskets shall be full face type. Follower gaskets shall be compression wedge type.

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

Dismantling joints may be used as takedown couplings in accordance with paragraph 15085-3.03. 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

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 15085-2.02 A.)

G. FLEXIJOINT

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

Gaskets designated in Section 15050 shall be as follows:

1. EPDM: ethylene-propylene-diene-terpolymer.

2. Neoprene: neoprene.

3. Nitrile: nitrile (Buna N).

4. 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).

5. 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).

6. Gylon gasketing, Garlock Style 3500, 2000 psi (ASTM F152), 0.22 ml/hr Fuel A (ASTM F37).

7. Gylon gasketing, Garlock Style 3510, 2000 psi (ASTM F152), 0.04 ml/hr Fuel A (ASTM F37).

8. Gylon gasketing, Garlock Style 3504, 2000 psi (ASTM F152), 0.12 ml/hr Fuel A (ASTM F37).

9. TFE: noncreeping tetrafluoroethylene (TFE) with insert filler.

10. PTFE bonded EPDM: PTFE bonded to EPDM in full-face gasket having concentric-convex molded rings; Garlock Stress Saver 370 or equal.

2.04 THREAD

Pipe thread dimensions and size limits shall conform to ANSI Bl.20.1.

2.05 DIELECTRIC UNIONS

Dielectric unions shall be EPCO, Capitol Manufacturing, or equal.

2.06 COATINGS

Unless otherwise specified, flange assemblies and mechanical type couplings for buried installation shall be field coated with System M-1 as specified in Section 09900.

2.07 PRODUCT DATA

In accordance with Section 01300, 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

Pipe cutting, threading and jointing shall conform to the requirements of ANSI B31.1.

3.02 PIPE WELDING

Pipe shall be welded by ASME-certified welders using shielded metal arc, gas shielded arc or submerged arc welding methods. Welds shall be made in accordance with the requirements of ANSI B31.1 for piping Systems 8, 26, and 28 specified in Section 15050. Welds shall be made in accordance with the requirements of ANSI B31.3 for piping System 20 specified in Section 15050. Welds for piping systems not specified above shall be made in accordance with AWWA C206.

3.03 TAKEDOWN COUPLINGS

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.

A union or flanged connection shall be provided within 2 feet of each threaded end valve.

3.04 FLEXIBILITY

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

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 15085-2.05 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

Where shown, equipment connection fittings shall be provided between field piping systems and equipment inlet and outlet connections.

** END OF SECTION**

SECTION 15096

PIPE HANGERS AND SUPPORTS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies hangers and supports for all piping systems specified in Section 15050. This section does not include pipe supports for fire sprinkler systems, pipe anchors, guides or seismic restraints.

B. OPERATING CONDITIONS:

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:

1. Hot Systems

A - 1. 120 degrees F to 450 degrees F
A - 2. 451 degrees F to 750 degrees F
A - 3. Over 750 degrees F

2. Ambient Systems

B. 60 degrees F to 119 degrees F

3. Cold Systems

C - 1. 33 degrees F to 59 degrees F
C - 2. -20 degrees F to 32 degrees F

C. HANGER AND SUPPORT SELECTION:

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 this section, the piping insulation thickness specified in Section 15250, and any special requirements which may be specified in the project manual.

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.

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 the operation of safety or relief valves.

4. Wind, snow or ice loadings on outdoor piping.

Hangers and supports shall be sized to fit the outside diameter of pipe, tubing, or, where specified, the outside diameter of insulation.

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.

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.

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.

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.

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.

Unless otherwise specified, existing pipes and supports shall not be used to support new piping.

Unless otherwise specified, pipe support components shall not be attached to pressure vessels.

Stock hanger and support components shall be used wherever practical.

1.02 REFERENCES

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.

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
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

1.03 SUBMITTALS

Hanger and support locations and components shall be indicated on the piping layout drawings required by paragraph 15050-1.03.

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

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. 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.

2.02 MATERIALS

A. GENERAL:

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 paragraph 16000-1.05 B, which shall be type 304 stainless steel.

B. PIPE HANGERS AND SUPPORTS:

1. TYPE 1 - CLEVIS PIPE HANGER: Clevis hangers shall be carbon steel with configuration and components equivalent to MSS and FEDSPEC Type 1.

a. Steel pipe (insulated) - shall be B-Line B3100, Grinnell Fig. 260, or equal, with insulation shield.

b. Steel pipe (uninsulated) - shall be B-Line B3100, Grinnell Fig. 260, or equal.

c. Cast and ductile iron pipe - shall be B-Line B3102, Grinnell Fig. 590, or equal.

d. Copper pipe (uninsulated) - shall be B-Line B3104 CT, Grinnell Fig. CT-65, or equal.

e. Copper pipe (insulated) - shall be B-Line B3100, Grinnell Fig. 260, or equal, with insulation shield.

f. Plastic pipe - shall be B-Line B3100 C, Carpenter & Patterson Fig. 100PVC, or equal.

2. TYPE 2 - "J" PIPE HANGER: Hangers shall be carbon steel with configuration and components equivalent to MSS Type 5.

a. Steel pipe - shall be B-Line B3690, Grinnell Fig. 67, Michigan model 418, or equal.

b. Copper and plastic pipe - shall be Michigan model 419, Unistrut J 1205N series, or equal.

3. TYPE 3 - DOUBLE BOLT PIPE CLAMP: Pipe clamp shall be carbon steel, with configuration and components equivalent to MSS and FEDSPEC Type 3.

a. Steel pipe (insulated) - shall be B-Line B3144, Grinnell Fig. 295, or equal, with insulation shield. Insulation shield is optional for hot and ambient systems.

b. Steel pipe (uninsulated) - shall be B-Line B3144, Grinnell Fig. 295, or equal.

c. Copper pipe (insulated only) - shall be B-Line B3144, Grinnell Fig. 295, or equal, with insulation shield.

4. TYPE 4 - ADJUSTABLE ROLLER HANGER: Rollers shall be cast iron, yoke and cross bolt shall be carbon steel. Configuration and components shall be equivalent to MSS Type 43 and FEDSPEC Type 44.

a. Steel pipe (insulated) - shall be B-Line B3110, Grinnell Fig. 181, or equal, with insulation shield.

b. Steel pipe (uninsulated) - shall be B-Line B3110, Grinnell Fig. 181, or equal.

c. Copper pipe (insulated only) - shall be B-Line B3110, Grinnell Fig. 181, or equal, with insulation shield.

d. Plastic pipe - shall be B-Line B3110, Grinnell Fig. 181, or equal.

5. TYPE 5 - SINGLE PIPE ROLL: Rollers and sockets shall be cast iron, cross rod shall be steel. Configuration and components shall be equivalent to MSS Type 41 and FEDSPEC Type 42.

a. Steel pipe (insulated) - shall be B-Line B3114, Grinnell Fig. 171, or equal, with insulation shield.

b. Steel pipe (uninsulated) - shall be B-Line B3114, Grinnell Fig. 171, or equal.

c. Plastic pipe - shall be B-Line B3114, Grinnell Fig. 171, or equal.

6. TYPE 6 - FRAMING CHANNEL PIPE CLAMP: Pipe clamps shall be steel with galvanized finish and material thickness as listed below:

a. Steel pipe (uninsulated) - Pipe size 3/8 inch and 1/2 inch shall be 16 gage; 3/4 inch through 1 1/4 inches shall be 14 gage; 1 1/2 inches through 3 inches shall be 12 gage; 3 1/2 inches through 5 inches shall be 11 gage; 6 and 8 inches shall be 10 gage; Michigan model 431, Powerstrut PS 1100, Unistrut P 1109 series, or equal.

b. Steel pipe (insulated) - Pipe clamp shall be as described in paragraph 15096-2.02 B.6.a with insulation shield.

c. Copper (uninsulated) and plastic pipe - Pipe size 3/8 inch and 1 inch shall be 16 gage; 1-1/4 inches and 1-1/2 inches shall be 14 gage; 2 inches through 3 inches shall be 12 gage; 4 inches shall be 11 gage; clamp shall be copper-plated, plastic coated or lined with dielectric material; Michigan model 432, Powerstrut PS 1200, Unistrut P 2024C and P 2024PC series, or equal.

d. Copper pipe (insulated) - Pipe clamp shall be as described in paragraph 15096-2.02 B.6.a with insulation shield.

7. TYPE 7 - U-BOLT: U-bolts shall be carbon steel with configuration equivalent to MSS and FEDSPEC Type 24.

a. Steel pipe (uninsulated) - shall be Grinnell Fig. 137, B-Line B3188, or equal.

b. Steel pipe (insulated) - shall be Grinnell Fig. 137, B-Line B3188, or equal, with insulation shield.

c. Cast and ductile iron pipe - shall be Grinnell Fig. 137, B-Line B3188, or equal.

d. Copper pipe (uninsulated) - shall be Carpenter & Patterson Fig. 222 CT, B-Line B3501 CT, Grinnell Fig. 137C, or equal.

e. Copper pipe (insulated) - shall be Grinnell Fig. 137, B-Line B3188, or equal, with insulation shield.

f. Plastic pipe - shall be Grinnell Fig. 137C, Michigan model 151, B-Line B3188 C, or equal.

8. TYPE 8 - ADJUSTABLE DOUBLE ROLLER SUPPORT: Rollers shall be non-metallic with hot-dip galvanized sockets and stainless steel hardware.

a. Stainless Steel pipe - shall be B-Line B3122ANM adjustable double roller guide, or equal.

9. TYPE 9 - WELDED PIPE STANCHION: Minimum material thickness shall be standard schedule carbon steel pipe, cut to match contour of the pipe elbow. Use of this support shall be limited to ambient systems only.

10. TYPE 10 - PIPE STANCHION SADDLE: Saddles and yokes shall be carbon steel and comply with MSS Type 37 and FEDSPEC Type 38.

a. Steel pipe (insulated) - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal, with insulation shield.

b. Steel pipe (uninsulated) - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal.

c. Cast and ductile iron pipe - shall be Carpenter & Patterson Fig. 125, B-Line B3090 NS, or equal.

d. Copper pipe (uninsulated) - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal, with insulation shield or lined with dielectric material.

e. Copper pipe (insulated) - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal, with insulation shield.

f. Plastic pipe - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal.

11. TYPE 11 - OFFSET PIPE CLAMP: Pipe clamp shall be carbon steel with configuration and components as specified and shall be of standard design manufactured by a pipe hanger component manufacturer.

a. Steel pipe (insulated) - shall be B-Line B3148, Grinnell Fig. 103, or equal, with insulation shield.

b. Steel pipe (uninsulated) - shall be B-Line B3148, Grinnell Fig. 103, or equal.

c. Cast and ductile iron pipe - shall be B-Line B3148 NS, Grinnell Fig. 103, or equal.

d. Copper pipe (insulated) - shall be B-Line B3148, Grinnell Fig. 103, or equal, with insulation shield.

e. Copper pipe (uninsulated) - shall be B-Line B3148, Grinnell Fig. 103, or equal, lined with dielectric material.

f. Plastic pipe - shall be B-Line B3148, Grinnell Fig. 103, or equal.

Vertical pipe support applications shall be as specified above except that insulation shields shall not be used for insulated pipe.

12. TYPE 12 - RISER CLAMP: Riser clamp shall be carbon steel with configuration and components equivalent to MSS and FEDSPEC Type 8.

a. Steel pipe (insulated) - shall be B-Line B3373, Grinnell Fig. 261, or equal.

b. Steel pipe (uninsulated) - shall be B-Line B3373, Grinnell Fig. 261, or equal.

c. Cast and ductile iron pipe - shall be B-Line B3373, Grinnell Fig. 261, or equal.

d. Copper pipe (insulated) - shall be B-Line B3373 CT, Grinnell Fig. CT-121, Michigan model 511, or equal.

e. Copper pipe (uninsulated) - shall be B-Line B3373 CT, Grinnell Fig. CT-121, Michigan model 511, or equal.

f. Plastic pipe - shall be B-Line B3373, Grinnell Fig. 261c, or equal.

13. TYPE 13 - FRAMING CHANNEL PIPE STRAP: Pipe strap shall be carbon steel, with configuration equivalent to MSS Type 26.

a. Steel pipe (uninsulated) - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal.

b. Steel pipe (insulated) - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal, with insulation shield.

c. Copper pipe (uninsulated) - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal, with insulation shield or lined with dielectric material.

d. Copper pipe (insulated) - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal, with insulation shield.

e. Plastic pipe - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal.

C. RACK AND TRAPEZE SUPPORTS:

1. GENERAL: 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.

2. TYPE 20 - TRAPEZE PIPE SUPPORT: Trapeze pipe support cross members shall be framing channel as specified in paragraph 15096-2.02 E.5. Flat plate fittings shall be 1 5/8-inch square carbon steel of standard design manufactured by framing channel manufacturer, Unistrut P2471, B-Line B202-2, or equal.

3. TYPE 21 - PIPE RACK SUPPORT: Post and cross members shall be framing channel as specified in paragraph 15096-2.02 E.5. Pipe rack fittings shall be carbon steel, of standard design manufactured by framing channel manufacturer. 90-degree fittings shall be gusseted Unistrut P2484, B-Line B844, or equal. Post base fittings shall be as specified in paragraph 15096-2.02 D.5.

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 15096-2.02 E.5. 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 15096-2.02 E.5. 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 15096-2.02 E.5.

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.

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.

2.03 THERMAL PIPE HANGER SHIELD

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 15250. 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.

A. 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.

B. 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 vaportight connection to pipe insulation vapor barrier.

PART 3--EXECUTION

3.01 HANGER AND SUPPORT LOCATIONS

The CONTRACTOR shall 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.

At least one hanger or support shall be located within 2 feet from a pipe change in direction.

The CONTRACTOR shall locate hangers and supports to ensure that connections to equipment, tanks, etc., are substantially free from loads transmitted by the piping.

Where piping is connected to equipment, a valve, piping assembly, etc., that will require removal for maintenance, the piping shall be supported in such a manner that temporary supports shall not be necessary for this procedure.

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

Welded and bolted 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.

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.

The CONTRACTOR shall install items to be embedded before concrete is poured. Fasten embedded items securely to prevent movement when concrete is poured.

Embedded anchor bolts shall be used instead of concrete inserts for support installations in areas below water surface or normally subject to submerging.

The CONTRACTOR shall 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.

Hanger and support components in contact with plastic pipe shall be free of burrs and sharp edges.

Rollers shall roll freely without binding.

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.

Baseplates shall be cut and drilled to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.

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

The CONTRACTOR shall 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.

END OF SECTION

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SECTION 15102

RESILIENT-SEATED GATE VALVES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies iron-body, resilient-seated gate valves.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to 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 shall prevail.

Reference	Title
ANSI B16.1-89	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800
ASTM A126-84	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
AWWA C-111-17	Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C-509-87	Resilient-Seated Gate Valves for Water and Sewerage Systems
AWWA C550	Protective Interior Coatings for Valves and Hydrants
NTUA	Navajo Area Standards & Construction Requirements

PART 2--PRODUCTS

2.01 GATE VALVES FOR WATER MAINS

Gate valves 3 through 12 inches in size shall comply with AWWA C509, including applicable hydrostatic testing. The seal shall be drop-tight. All internal and external surfaces of the valve including the interior of the gate shall be coated with a two part epoxy coating in accordance with AWWA C550.

Valve working pressure rating shall the greater of 235 psi minimum or equal to or greater than the rated pressure of the waterline on which the valve is installed.

Gate valves shall be supplied by a single manufacturer.

2.02 MATERIALS

The body of the valve shall be cast iron, with a full round port opening equal to or exceeding the diameter of the corresponding pipe. The body shall have integrally cast guides to insure the gate is properly guided through complete travel, and shall be free of pockets and bridges in the valve bottom.

The sealing mechanism shall consist of a free draining bi-directional compression seating gate, which ensures a 100 percent bubble tight seal in the closed position against the line flow. The gate shall be constructed with a rubber seal mechanically retained between two epoxy coated gate halves which are securely fastened with stainless steel recessed capscrews.

Gate valves shall be of the nonrising stem type. The stem shall be 400 series stainless steel and shall be independent of the bronze stem nut. A four bolt bonnet cover shall contain a grit and dust cap protecting two O-ring stem seals and the nylon bushing located above the stem collar. A teflon washer shall be located between the stem collar and bonnet as an antifriction device.

End connections shall be furnished as specified in Section 15050 and shown on the drawings. Mechanical joints are to be per ANSI/AWWA C111/A21.11; flanged joints shall conform to ANSI standard B16.1, Class 150. End connections shall be restrained.

2.03. MANUAL OPERATORS:

Gate valves shall be provided with counter clockwise opening geared operators.

Exposed valves shall be supplied with an enclosed bevel gear and handwheel to permit side operation.

Buried valves shall be provided with enclosed spur gears and 2" square operating nuts to permit operation through a valve box from above.

2.04 VALVE BOXES

Valve boxes shall be installed on all buried valves and shall be 5-1/4-inch Nominal diameter shaft, two-piece adjustable screw type equal to Tyler no. 6850 series. The length of the box shall be sufficient to permit access to the valve at the specified depth of bury. Tyler series extensions will be utilized to extend the valve box when required. The word "water" shall be cast onto the Lid.

2.05 SUBMITTAL DATA

The following information shall be provided in accordance with Contractor submittal requirements:

1. Full product submittal including manufacturer’s cut sheets, details of construction, and product information.

PART 3--EXECUTION

3.01 VALVE INSTALLATION

Gate valves shall be installed in the closed position.

Before installing the valve, care shall be taken to see that all foreign material and objects are removed from the interior of the valve. The valve shall be opened and closed to see that all moving parts are in working order.

All valves shall be set and jointed to the pipe in the manner as set forth in the AWWA Standards for the type of connecting ends furnished. All valves shall be set in and tied to poured in-place concrete support blocks as per the NTUA Standard Detail, WS-14.

Valves and valve boxes shall be set plumb and valves boxes shall be placed over the valve in such a manner that the valve box does not transmit shock or stress to the valve. The cast iron valve box cover shall be set flush with, or slightly above, the finished grade. A 2-foot by 2-foot by 4-inch reinforced concrete pad shall be poured around each valve box. Before the concrete has hardened, the Contractor shall neatly scribe in the concrete pad the valve size and a line representing the direction of flow of water through the valve.

END OF SECTION

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SECTION 15103

BUTTERFLY VALVES

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies butterfly valves for water service.

1. TYPE A: Valves used in the following piping systems for sizes 3 inches and larger shall be designated Type A.

Piping systems
7

1.02 REFERENCES

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.

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 B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings
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 A436	Austenitic Gray Iron Castings
ASTM A536	Ductile Iron Castings
AWWA C504	Rubber-Seated Butterfly Valves
NTUA	Navajo Area Standards & Construction Requirements

PART 2--PRODUCTS

2.01 MATERIALS

A. TYPE A:

Type A valves are specified according to size as follows:

1. TYPE A, SIZE 2 THROUGH 24 INCHES: Type A valves from 2 through 24 inches in size shall be constructed of the following materials unless otherwise specified:

Component	Material
Shaft	Stainless steel, ASTM A276, Type 304 Carbon steel, ASTM A108, with stainless steel journals
Disc	Ductile iron, ASTM A536, or cast iron, ASTM A436, type 1 (Ni-Resist); or ASTM A48, Class 40, or ASTM A126, Class B
Seat mating surface	Stainless steel, ASTM A276, Type 304, mounted in body or on disc edge; or Ni-Chrome on the disc edge
Seat sealing surface	Neoprene, EPDM or Buna N
Body	Cast iron, ASTM A126, Class B

2.02 MANUFACTURE

A. GENERAL:

Valves shall be flanged. Wafer type valves are not acceptable. Unless otherwise specified, valve flange drilling shall be per ANSI B16.1, Class 125.

B. TYPE A:

Type A valves shall be designed in accordance with AWWA C504. Shafts shall be turned, ground and polished. Shaft dimensions and operator torque shall be chosen for the pressure specified in Section 15050 and Class B as specified in AWWA C504. When carbon steel shafts and stainless steel journals are used, static seals shall be provided to isolate the interior of the disc and the shaft from the process fluid.

Type A valves shall have seats that are vulcanized, bonded, mechanically secured, or clamped to the body or disc.

2.03 MANUAL OPERATORS

A. GENERAL:

Manual operators shall be designed in accordance with AWWA C504 and shall have a disc position indicator designating the opened and closed position of the valve.

B. TYPE A:

Operators for valves 6 inches in diameter and smaller shall be latch lock levers. Valves shall be capable of being locked in at least five intermediate positions between fully open and fully closed.

Manual operators larger than 6 inches shall be of the traveling nut, rack and pinion, or worm gear type. Operators shall be equipped with adjustable mechanical stop-limiting devices to prevent overtravel of the disc in the open and closed positions and shall be self-locking and designed to hold the valve in any intermediate position between full open and full closed. Valve operator components shall withstand an input torque of 300 ft-lbs at the extreme operator positions without damage.

Operator for buried service shall include an AWWA operating nut and shall be gasketed and grease packed for submerged operation at water pressures to 10 psig. Operators for exposed service shall include a handwheel and be gasketed for weatherproof service.

2.04 PRODUCT DATA

Affidavits of compliance with AWWA C504 for Type A valves shall be provided in accordance with Section 01300.

PART 3--EXECUTION

Valves shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 15150

AIR RELEASE AND VACUUM VALVES FOR CLEAN WATER SERVICE

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

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 shall be as specified.

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. AIR VALVES FOR VERTICAL TURBINE PUMPS: Air valves for vertical turbine pumps (ATP) shall consist of an air and vacuum valve with throttling device for sizes 3-inch and less, and a dual body construction combination air valve mounted on top of a surge check for sizes 4-inch and larger. Size and capacity shall be as specified.

1.02 REFERENCES

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.

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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

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

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

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

Air release valves shall be float operated, compound lever type, except air release valves less than 1-inch may be simple lever type.

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.

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. All combination air valves shall be 1-inch in size.

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.

Valves shall be suitable for pressures up to 150 psi.

2.04 PRODUCT DATA

The following information shall be provided in accordance with Section 01300:

1. Manufacturer's product data.

2. Applicable O&M instruction manuals per Section 01730.

PART 3--EXECUTION

Air release and vacuum valves shall be installed in accordance with the manufacturer's recommendations. Unless otherwise specified, isolation valves per Section 15050 shall be provided below each air valve. Piping from air release and vacuum valves shall be provided to equipment drains or floor drains, located in the Pump Houses for the disposal of nuisance water releases.

END OF SECTION

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SECTION 15153

PRESSURE REGULATING VALVES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies direct acting and pilot-controlled pressure regulating valves for water service.

1.02 QUALITY ASSURANCE

A. REFERENCES:

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.

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

B. PERFORMANCE:

Direct acting type pressure regulating valves shall control the discharge pressure within ±5 percent of set pressure.

Pilot controlled type pressure regulating valves shall maintain the set discharge pressure regardless of fluctuations in inlet pressure.

C. TESTING:

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.

1.02 SCHEDULE

Valve number	Service	Valve size, inches	Maximum flow, scfm or gpm	Inlet pressure range, psig	Outlet pressure, psig
PRV No. 1		4	800	122	108
PRV No. 2		4	800	140	53
PRV No. 3		4	800	122	25
PRV No. 4		4	800	86	58
PRV No. 5		4	800	144	118
PRV No. 6		4	800	128	92

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. GENERAL:

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. WATER SERVICE:

Valves less than 1-1/4 inches shall be direct acting, spring-operated type. Valves less than 1-1/4 inches shall be Cash-Acme E-41 Series 3, Watts 223, or equal, with separate Y-pattern strainer.

Valves 1-1/4 inches and larger shall be pilot-controlled type, unless otherwise specified. Valves 1-1/4 inches and larger shall be diaphragm actuated type or differential piston pressure type and shall be Cla-Val Co. Clayton 90-01 Series, GA Industries, Inc., or equal.

2.02 PRODUCT DATA

The following information shall be provided in accordance with Section 01300:

1. Manufacturer's product data.

2. Hydrostatic test results.

PART 3--EXECUTION

Pressure regulating valves shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

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SECTION 15184

MANUAL VALVE AND GATE OPERATORS AND OPERATOR APPURTENANCES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies manual operators for valves and operator appurtenances.

1.02 REFERENCES

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.

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
NTUA	Navajo Area Standards & Construction Requirements

PART 2--PRODUCTS

2.01 GENERAL

Except as specified in valve specification sections, manual operators shall be as specified herein. Operators shall be mounted on the valve 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:

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:

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:

Chain wheels shall be ductile iron. Operating chains shall be galvanized.

2.03 OPERATOR APPURTENANCES

A. 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.

B. 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.

C. 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."

2.04 PRODUCT DATA

Manufacturer's catalog information and other data confirming conformance to design and material requirements shall be provided in accordance with Section 01300.

PART 3—EXECUTION

3.01 GENERAL

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:

Valves 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:

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:

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:

Valve boxes extending to finished surfaces shall be provided for buried valves.

B. FLOOR BOXES:

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 15762

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. Propeller unit heaters with 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.

PART 2 - PRODUCTS

2.01 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: An 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

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SECTION 15815

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.

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. Prepare test and inspection reports.

3.06 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

3.07 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel:

B. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

C. Liner:

1. Fibrous glass, Type I.

END OF SECTION 15815

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SECTION 15820

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.

B. Related Sections include the following:

   1. Division 22 and 23 Section "HVAC Instrumentation and Controls" for electric and pneumatic 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.

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."

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.

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. 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 15820

SECTION 15838

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. In-line centrifugal 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. Field quality-control reports.

C. 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.

1.07 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.01 IN-LINE CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acme Engineering & Manufacturing Corporation.
2. American Coolair Corporation.
3. Carnes Company.
4. Greenheck Fan Corporation.
5. Loren Cook Company.
6. PennBarry.
7. 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. Companion Flanges: For inlet and outlet duct connections.
2. 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.
3. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.02 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.

2.03 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 having a static deflection of. 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. Install units with clearances for service and maintenance.

D. 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 15838

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SECTION 15855

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. 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 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 15855

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SECTION 15857

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.
      7)
   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. Bird Screen:
    1. Aluminum: Aluminum, 1/2 inch mesh by 0.063 inch (13 mm mesh by 1.6 mm), intercrimp.
    2. Steel: Galvanized steel, 1/2 inch mesh by 19 gage (13 mm mesh by 1.1 mm), intercrimp.
    3. 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. Color for Kynar Finish:
    1. Color: Custom. Refer to Drawings.

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 15857

SECTION 15950

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.

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. Verifying that automatic control devices are functioning properly.
4. 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. 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.

1.05 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by AABC or NEBB.

1.06 PROJECT CONDITIONS

A. 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.

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 Applicable)

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 equipment for installation and for properly operating safety interlocks and controls.

K. 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. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
4. Interlocked systems are operating.

L. 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.

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 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
2. Air Outlets and Inlets: 0 to minus 10 percent.
3. Heating-Water Flow Rate: 0 to minus 10 percent.
4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.07 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.

3.08 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.

3.09 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.

3.10 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 15950

Navajo Nation
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

CAMERON PUMP STATIONS AND PRESSURE RELIEF VALVES

DIVISION 16

ELECTRICAL

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SECTION 16000

GENERAL REQUIREMENTS FOR ELECTRICAL WORK

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies general requirements for electrical work for modifications to the Cameron water system. 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.

Schedule and coordinate work to minimize water system control outages. Refer to Sections 01014 and 17900.

Summary of work, is further detailed in Section 17000:

1. Cameron Tanks No. 1 and 2 exist. This site communicates with existing Pressure Reducing Valve No. 6 and new Pump Station No. 1 sites via existing telemetry, and relays signals to SCADA equipment at the adjacent Microwave Tower. Provide cable and conduit from telemetry to SCADA. The existing telemetry unit serving existing Wells No. 1 and 2 is not modified. Provide SCADA.

2. Cameron Well No. 1 exists.

3. Cameron Well No. 2 exists.

4. Provide Cameron Pump Station No. 1. Provide equipment and telemetry inside building. Test and verify operation of Station to control tank level. Test telemetry to existing Cameron Tanks No. 1 and 2.

5. Provide Cameron Pump Station No. 2. Provide equipment and telemetry inside building. Test and verify operation of Station to control discharge pressure. Test telemetry to the existing Bodaway-Gap Tank via the existing Bodaway-Gap Electrical Substation (provided under separate Contract).

6. Provide Cameron Pump Station No. 3. Provide equipment and telemetry inside building. Test and verify operation of Station to control discharge pressure. Test telemetry to the existing Bodaway-Gap Tank via the existing Bodaway-Gap Tank via Bodaway-Gap Electrical Substation (provided under separate Contract).

7. Provide telemetry units per details from Navajo Area Indian Health Service/NTUA – Technical Provisions 4.0 for PLC Control Panel (Booster with BoosterPAQ) included in the Drawings.

8. Provide work as specified and per Indian Health Services – Navajo Nation – Standard Drawings.

9. Provide testing per Section 01660, 16030, and 17030.

10. Provide arc flash hazard analysis and labeling per Section 16431.

11. Telemetry PLC and touchscreen programming will be provided as specified in Paragraph 17000-1.01 B, coordinate work, programmers, and provide testing.

12. Equipment to be Owner furnished:

a. Only that which is labeled as "EXISTING" on drawings.

13. All replaced or removed items shall be salvaged. Salvaged items shall be properly disconnected to retain their full salvage value and cleaned before turning over to the Owner.

14. Work for this system is related to work for the Bodaway-Gap water system, refer to Spec. 01010.

B. DEFINITIONS:

1. ELEMENTARY OR SCHEMATIC DIAGRAM: 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 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 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. WIRING DIAGRAM OR CONNECTION SYSTEM: A wiring or connection diagram includes all of the devices in a system and shows their physical relationship to each other including terminals and interconnecting wiring in an assembly. This diagram shall be (a) in a form showing interconnecting wiring only by terminal designation (wireless diagram), or (b) a panel layout diagram showing the physical location of devices plus the elementary diagram.

5. ARRANGEMENT, LAYOUT, OR OUTLINE DRAWINGS: 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:

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.

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) 2017
NFPA-70E	Electrical Safety in the Workplace
ACI 318	Building Code Requirements for Structural Concrete
	Navajo Area Indian Health Service/NTUA – Technical Provisions 4.0
	Indian Health Service – Navajo Nation – Standard Drawings

B. IDENTIFICATION OF LISTED PRODUCTS:

Electrical equipment and materials shall be 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). Independent testing laboratory shall be acceptable to the inspection authority having jurisdiction.

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. FACTORY TESTS:

Where specified in the individual product specification section, factory tests shall be performed at the place of fabrication and performed on completion of manufacture or assembly. The costs of factory tests shall be included in the contract price.

D. POWER UTILITY:

1. The power utility for Cameron Pump Station No. 2 and No. 3 is Navajo Tribal Utility Authority (NTUA).

2. The power utility for Cameron Pump Station No. 1 is Arizona Public Service (APS).

3. Coordinate power utility connection with the power utility. Provide installations per their requirements.

4. Provide submittals per paragraph 1.03 B.

1.03 SUBMITTALS

The following submittals shall be provided in accordance with Section 01300:

A. 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. 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 Drawings E-100 through E-130 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. 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. Submit catalog cuts for only the following:

   a. Service Entrance Meter Socket.

   b. Any proposed alternates to specified manufacturers and model equipment.

B. POWER UTILITY:

1. After shop drawing review, submit Service Entrance Meter Socket to power utility for review. Provide separate submittals for each of the following sites:

   a. Cameron Pump Station No. 1.

   b. Cameron Pump Station No. 2.

   c. Cameron Pump Station No. 3.

1.04 DRAWINGS

Where the Contractor is required to provide information on drawings as part of the specified work, such drawings shall be prepared on 11 by 17 inch drafting media complete with borders and title blocks clearly identifying project name, equipment and the scope of the drawing.

Drawing quality and size of presentation shall be such as to permit 50 percent reduction of such drawings for insertion in operation and maintenance manuals.

1.05 PROJECT/SITE CONDITIONS

A. GENERAL:

Unless otherwise specified, equipment and materials shall be sized and derated for the ambient conditions specified in Section 01800, but not less than an ambient temperature of 40 degrees C at an elevation ranging from sea level to 4,500 feet without exceeding the manufacturer's stated tolerances.

B. CORROSIVE AREAS:

The following areas are designated as corrosive: None.

C. HAZARDOUS (CLASSIFIED) AREAS:

The following areas are designated as hazardous (classified) in accordance with the NEC: None.

D. SEISMIC:

Electrical equipment, supports, and anchorage shall be designed and installed in accordance with the seismic design requirements specified in Section 01900 and on the Structural drawings.

1.06 STORAGE OF MATERIALS AND EQUIPMENT

Materials and equipment shall be stored as specified in paragraph 01605-3.0 E. Equipment and materials to be located indoors shall be stored indoors and sealed with plastic film wrap.

PART 2--PRODUCTS

2.01 EQUIPMENT AND MATERIALS

A. GENERAL:

Equipment and materials shall be new and free from defects. All material and equipment of the same or a similar type shall be of the same manufacturer throughout the work. Standard production materials shall be used wherever possible.

B. EQUIPMENT FINISH:

Unless otherwise specified, electrical equipment shall be painted by the manufacturer.

2.02 600 VOLT WIRE AND CABLE

A. INSULATION:

1. MEPR/CPE multi-conductor control cable, XLP or CPE insulation and jacket.

2. XHHW-2 for single conductors

3. THWN for indoor lighting and receptacles

4. PVC jacket and insulation for shielded signal cables.

5. Coaxial cable as specified in Section 17000.

6. Ethernet cable, CAT6 with factory attached RJ-45 connections.

7. SOOW or SJOOW for portable cord.

B. CONDUCTORS:

1. Copper, stranded per ASTM B8.

C. COLOR CODING:

1. CONTROL CONDUCTORS:

Single-conductor control conductors shall have the following colors for the indicated voltage:

Control Conductor	120V
Power (AC)	Black
Control (AC)	Red
Neutral	White
Ground	Green
Power (DC)	Blue
Control (DC)	Violet

2. POWER CONDUCTORS:

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	-	White

Cables may be black with colored 3/4-inch vinyl plastic tape applied at each cable termination. Tape shall be wrapped with 25 percent overlay to provide 3 inches minimum coverage.

3. SIGNAL CONDUCTORS:

Signal cable conductors shall be color coded black and white for pairs or black, white, and red for triads.

D. SPLICING AND TERMINATING MATERIALS:

Connectors shall be tool applied compression type of correct size and UL listed for the specific application. Connectors shall be tin-plated high conductivity copper.

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.

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.

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.

E. CORD GRIPS:

Cord grips shall be provided where indicated on the Drawings to attach flexible cord to equipment enclosures. Cord grips shall consist of a threaded aluminum body and compression nut with a neoprene bushing and stainless steel wire mesh for strain relief. Cord grip shall provide a watertight seal at enclosure interface and sized to accommodate the flexible cord.

F. WIRE MARKERS

Each power and control conductor shall be identified at each terminal to which it is connected. Conductors size No. 10 AWG or smaller shall have identification sleeves. Conductors No. 8 AWG and larger shall use cable markers of the locking tab type. Tabs shall be white plastic with conductor identification number permanently embossed.

Conductors shall be identified in accordance with paragraph 16000-1.07 B. Adhesive strips are not acceptable.

The letters and numbers that identify each wire shall be machine printed on sleeves with permanent black ink with figures 1/8 inch high. Sleeves shall be yellow or white tubing and sized to fit the conductor insulation. Shrink the sleeves with hot air after installation to fit the conductor.

Conductor and Wire Marker Manufacturer:

1. TMS Thermofit Marker System by Raychem Co.

2. Sleeve style wire marking system by W. H. Brady Co.

3. Or equal.

2.03 RACEWAY

A. BOXES AND GUTTERS:

1. Building interior, outdoors: Painted Steel, NEMA 3R.

B. SUPPORTS, HANGERS, AND RACKS:

1. Building interior, outdoors: Galvanized Steel.

C. RACEWAY:

1. Building interior, outdoors: Galvanized rigid steel.

2. Underground: PVC schedule 40, taped or PVC coated rigid steel 90 degree elbows at transition to above-ground.

3. Final connections: Liquidtight flexible conduit.

D. RACEWAY MARKERS:

1. Solid brass with 0.036-inch minimum thickness.

2. Raceway number stamped or engraved in 3/16-inch minimum height characters

3. Attached to the raceway with 316 stainless steel wire.

4. Engraving per circuits shown on panel schedules and one-line diagrams.

E. UNDERGROUND MARKING TAPE

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.

Marking 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."

Tape Products: Brady "Identoline"; Services and Materials "Buried Underground Tape"; Somerset (Thomas & Betts) "Protect-A-Line"; or equal.

2.04 COMPONENTS

A. 120V RECEPTACLES:

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 polycarbonate weatherproof-in-use covers.

Manufacturers: Hubbell 53CM62/53CM21, or equal.

B. SWITCHES:

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.

Manufactures: Hubbell or Arrow-Hart as follows:

	Hubbell with 17CM50 plate	Arrow-Hart with 2881 plate
Single pole	1281	2991
Double pole	1282	2992
3-way	1283	2993
4-way	1284	2994

C. DEVICE PLATES:

Device plates shall be corrosion-resistant/marine-duty type.

D. LUMIINAIRES:

Provide as specified on drawings. Provide lamps where applicable.

E. GROUND RODS:

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.

F. GROUNDING CONNECTORS:

1. Compression connections shall be irreversible, cast copper as manufactured by Thomas and Betts, or equal.

2. Bolted connectors shall be Burndy, O. Z. Gedney, or equal.

3. 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.

G. TEST WELLS:

Provide concrete test well with cover and connect the ground grid extension using a removable connector.

H. TERMINAL BLOCKS:

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.

I. MANUAL STARTERS:

Manual starters shall comprise a horsepower rated quick-make, quick-break, toggle mechanism together with overloads in all phase conductors. Size the overload relay elements for the actual nameplate full load amperes of the motor connected to the starter.

2.05 EQUIPMENT

A. TRANSFORMERS:

Provide as specified on drawings.

B. LOAD CENTERS:

1. Provide as specified on drawings.

2. Provide metal oxide varistor (MOV) surge protective device (SPD) integral within each panelboard that indicates the status and condition of the SPD, tested per NEMA LS-1, rated IEEE C3 Combined Wave of 20kV and 10kA with 200kAIC internal fusing and listed / labeled per UL 1449.

3. 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.

C. SAFETY DISCONNECT SWITCHES:

Heavy duty fused and non-fused disconnect switches with current range of 30 to 600 amperes shall be provided as shown on the drawings with the enclosure type matching the area rating. Provide lock-off provision for a hasp padlock. Provide visible knife blades through a cover viewing window. Provide shielded or insulated line terminals with quick-make / quick-break switch operator. Provide internal barrier kit for additional personnel barrier from accidental contacts with live parts. Provide a legend plate with equipment tag, equipment description, and power feeder circuit source and location identification.

Fuse clips shall be Class R rejection type and sized for UL Class R, one-time, time-delay fuses. Fuse assembly shall have a minimum short circuit capacity of 100,000 amps symmetrical. Provide fuses as shown and one set of spare fuses with each switch.

D. SERVICE ENTRANCE METER SOCKET:

Provide as specified on drawings.

E. TELEMETRY PLC:

Provide as specified on drawings. Refer also to Spec. 17110.

F. DOOR SWITCH:

Provide as specified on drawings.

2.06 NAMEPLATES

A. MATERIALS:

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.

B. ENGRAVING:

1. Abbreviations shall be submitted to the Construction Manager prior to manufacture because of space limitations.

2. Nameplate adhesives will not be permitted on the outside of enclosures.

3. Provide nameplate for each electrical equipment item engraved as follows: (EQUIPMENT NAME) / (VOLTAGE) VOLTS.

2.07 PRODUCT DATA

The following information and product data specified under individual specification sections shall be provided in accordance with Section 01300.

1. Applicable operation and maintenance information on an item-by-item basis in accordance with Section 01730. Include final reviewed submittal.

2. Record documents specified in paragraph 16000-3.03.

PART 3--EXECUTION

3.01 GENERAL

A. CONSTRUCTION:

The work under Division 16 shall be performed in accordance with these specifications.

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.

Electrical layout drawings are diagrammatic, unless otherwise detailed or dimensioned. The Contractor shall coordinate the location of electrical material or equipment with the work.

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 of Record for the project for review.

Minor changes in location of electrical material or equipment made prior to installation shall be made at no cost to the Owner.

B. CONDUITS IN CONCRETE CONSTRUCTION:

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:

1. Concrete strength shall not be impaired significantly by the embedment of conduits in or through structural sections.

2. Conduit layout shall conform to the requirements of ACI 318, Sections 3.3 – Aggregates and 6.3 – Conduits and Pipes Embedded in Concrete.

3. Conduits shall be treated similarly to reinforcing steel for purposes of clearance. In general, code sections require conduit spacing the greater of:

    a. 1.33 times the maximum concrete aggregate size, clear

    b. Three diameters center to center

Alternate spacing and layout shall be as reviewed and accepted by the Engineer.

4. Conduit and raceway penetrations through walls and slabs where one side is a conditioned or an occupied space and the other side not, or one side has liquid or groundwater contact and the other not, shall be detailed and constructed to prevent liquid and moisture penetration through the wall or slab section for each conduit.

C. HOUSEKEEPING:

Electrical equipment shall be protected from dust, water and damage. Motor control centers, switchgear, and buses shall be wiped free of dust and dirt, kept dry, and shall be vacuumed on the inside within 30 days of acceptance of the work.

Before final acceptance, the Contractor shall touch up any scratches on equipment.

Electrical equipment temporarily exposed to weather, debris, liquids, or damage during construction shall be protected as specified in paragraph 01605-3.0 F.

D. ELECTRICAL EQUIPMENT LABELING

Electrical equipment shall have field marked signs and labeling to warn qualified persons of the potential electric arc flash hazards per NEC Article 110.16 Flash Protection.

Electrical equipment shall have NFPA 70E labels installed stating the results of the Arc Flash analysis specified in Section 16431 Short Circuit and Protective Device Coordination Study Report.

Electrical distribution equipment and utilization equipment shall be 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.

E. MOTOR CONNECTIONS

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.

F. CONDUCTOR INSTALLATION

An enclosure containing disconnecting means, overcurrent devices, or electrical equipment shall not be used as a wireway or raceway for conductors not terminating within the

enclosure. Provide wireways, raceways, termination boxes, or junction boxes external to the enclosure for the other conductors.

3.02 TESTING

A. GENERAL:

Refer to Section 16030.

3.03 RECORD DOCUMENTS

Contract documents shall be maintained and annotated by the Contractor during construction, including the record drawings specified in Section 01720.

END OF SECTION

SECTION 16030

ELECTRICAL ACCEPTANCE TESTING

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies the acceptance testing of electrical materials, power distribution and utilization equipment and circuits. Contractor shall provide all labor, tools, material, power, and other services necessary to provide the specified tests.

B. SCHEDULE:

Provide testing for all equipment at the following sites:

1. Cameron Pump Station No. 1.

2. Cameron Pump Station No. 2.

3. Cameron Pump Station No. 3.

1.02 REFERENCES:

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.

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
NFPA-70	National Electrical Code (NEC)

1.03 SUBMITTALS

A. PRE TEST:

1. Functional testing and checkout procedures and schedule shall be provided in accordance with Section 01300.

PART 2--PRODUCTS

2.01 TEST EQUIPMENT AND MATERIALS

Test instruments shall be calibrated to references traceable to the National Institute of Standards and Technology and shall have a current sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required.

2.02 PRODUCT DATA

In accordance with Section 01300, the Contractor shall submit the completed test report forms for each site as specified in Part 3 herein.

PART 3--EXECUTION

3.01 TESTING

A. GENERAL:

The following specified tests, including correction of defects where found and the subsequent re-testing, shall be completed prior to energization of the equipment or systems. Submit all completed test report forms in a 3-ring binder type notebook at the project Substantial Completion date.

A 1,000 volt megohmmeter shall be used for insulation resistance measurements.

B. INSULATION RESISTANCE MEASUREMENTS:

1. GENERAL: Insulation resistance measurements shall be made on conductors and electrical equipment that will carry current. Minimum acceptable values of insulation resistance shall be in accordance with the applicable NETA-ATS, ICEA, NEMA, or ANSI standards for the equipment or material being tested. The ambient temperature at which insulation resistance is measured shall be recorded on the test form.

2. CONDUCTOR AND CABLE TESTS: The phase-to-ground insulation resistance shall be measured for all 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 in a format similar to Form 16000-A and 17000-A contained in Section 01999, and submitted for acceptance. Insulation with resistance of less than 10 megohms is not acceptable.

3. MOTOR TESTS: The Installed Motor Test Form, 16000-B, contained in Section 01999, shall be completed for each motor after installation and submitted for acceptance. All motors shall have their insulation resistance measured before they are connected.

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.

Verify that motors are connected to rotate in the correct direction. 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.

4. POWER DISTRIBUTION EQUIPMENT: Transformers, panelboards, and other power distribution equipment shall have their insulation resistance measured phase-to-phase and phase-to-ground. Utilize forms 16000-C and D provided in Section 01999 as examples.

5. POWER UTILIZATION EQUIPMENT: Test receptacles and power outlets using a device to verify polarity, grounding, and the correct wiring connections.

C. FUNCTIONAL TESTING:

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.

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 17. 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.

3.02 PROTECTIVE DEVICE FIELD SETTINGS

The Contractor or Study 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 16431 have been implemented.

3.03 ARC FLASH SIGN INSTALLATION

The Contractor shall install the Arc Flash Hazard signs per direction from Section 16431 Study Firm.

END OF SECTION

SECTION 16431

ARC FLASH AND SHOCK RISK ASSESSMENT, SHORT CIRCUIT STUDY, AND PROTECTIVE DEVICE COORDINATION REPORT

PART 1--GENERAL

1.01 DESCRIPTION

A. GENERAL:

This section specifies that the Contractor subcontract an independent full member NETA Engineering and Study Firm / Testing Firm to prepare:

1. Electrical equipment short circuit study (SCS).

2. Protective device coordination study (PDCS) report.

3. Arc flash analysis (AFA) and labeling.

B. SCHEDULE:

Provide study, report, and labeling for all equipment at the following sites:

1. Cameron Pump Station No. 1.

2. Cameron Pump Station No. 2.

3. Cameron Pump Station No. 3.

C. SCOPE:

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.

Report shall also include analysis of the equipment's short circuit ratings, protective device ratings and protective device settings affected by the installed equipment.

Report shall include the results of the arc flash hazard analysis study for energized electrical equipment in accordance with the methods outlined in IEEE Standard 1584 and stated hereinafter.

Work shall include the fabrication of signs with the arc flash hazard study results and the installation of the signs on the equipment in accordance with NFPA 70E Table 3-3.9.3 that includes

the personnel protective equipment (PPE) risk category, the energy available, and the clothing recommendation.

1.02 QUALITY ASSURANCE

A. REFERENCES:

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.

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
NFPA 70E	Standard for Electrical Safety in the Workplace
NETA ATS	Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems, 1999

B. QUALIFICATIONS:

The short circuit and coordination report shall be performed, and signed by the professional electrical engineer (Study Firm) responsible for the studies and registered to practice engineering in the state of Arizona.

1.03 SCHEDULE

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.

A copy of the Construction Manager accepted report shall be sent by the Contractor to all affected manufacturers prior to fabrication.

1.04 SUBMITTALS

The report specified in this Section shall be provided in accordance with Section 01300.

PART 2--PRODUCTS

2.01 REPORT

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.

A. REQUIREMENTS:

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. Assumptions made during the study.

PART 3--EXECUTION

3.01 GENERAL

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 ANSI method of short circuit analysis in accordance with ANSI C37.010.

The studies shall be performed using actual equipment data. The coordination study shall use the data from the same manufacturer of protective relay and overcurrent devices as being provided by the equipment manufacturer.

For new equipment, the Contractor shall provide copies of final reviewed equipment submittals upon request by the Study Firm.

Any power distribution equipment outages shall be scheduled in advance and coordinated with the Owner to limit water service outages.

3.02 NOT USED

3.03 SHORT CIRCUIT STUDY

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:

A. ONE-LINE DIAGRAM:

1. Location and function of each protective device in the system, such as relays, direct-acting trips, fuses, etc.

2. Type designation, current rating, range or adjustment, manufacturer's style and catalog number for all protective devices.

3. Power, voltage ratings, impedance, primary and secondary connections of all transformers.

4. Type, manufacturer, and ratio of all instrument transformers energizing each relay.

5. Nameplate ratings of all motors and generators.

6. Sources of short circuit currents such as utility ties, generators, and induction motors.

7. Significant circuit elements such as transformers, cables, breakers, fuses, reactors, etc.

8. Emergency as well as normal switching conditions, as applicable.

9. The time-current setting of existing adjustable relays and direct-acting trips, as applicable.

B. IMPEDANCE DIAGRAM:

1. Available 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: 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 AND SHOCK RISK ASSESSMENT

The Contractor shall be responsible to obtain and verify all data needed to perform the study. The arc flash and shock risk assessment 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

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 tap and time dial 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

The Study Firm or Contractor shall implement the protective device coordination study settings on new equipment as required in Section 16030, based on the Engineers accepted Protective

Device Coordination Report specified herein and submit a final amended report of the Record As-Built electrical equipment protective device settings subsequent to start-up and testing.

3.07 ARC FLASH SIGN INSTALLATION

The Study Firm shall work with the Contractor for implementing the Arc Flash Hazard sign installation requirements for electrical equipment as specified in NEC Article 110.16 Flash Protection and NFPA 70E.

END OF SECTION

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Navajo Nation
WESTERN NAVAJO PIPELINE PHASE 1

BC PROJECT NO.: 150360

CAMERON PUMP STATIONS AND PRESSURE RELIEF VALVES

DIVISION 17

INSTRUMENTATION

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SECTION 17000

GENERAL REQUIREMENTS FOR
INSTRUMENTATION AND CONTROL

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies general requirements which are applicable to providing a complete, functional process control, instrumentation, communication, and telemetry systems and modifications to the Cameron water system. The requirements of this section are applicable to all work specified in Division 17 of these specifications.

Schedule and coordinate work to minimize water system control outages. Refer to Sections 01014 and 17900.

Electrical requirements applicable to this work include those specified in Section 16000 for general electrical requirements.

B. DESCRIPTION OF WORK:

1. Cameron Tanks No. 1 and 2 exist. This site communicates with existing Pressure Reducing Valve No. 6 and new Pump Station No. 1 sites via existing telemetry, and relays signals to SCADA equipment at the adjacent Microwave Tower. Provide cable and conduit from telemetry to SCADA. The existing telemetry unit serving existing Wells No. 1 and 2 is not modified. Provide SCADA .

2. Cameron Well No. 1 exists.

3. Cameron Well No. 2 exists.

4. Provide Cameron Pump Station No. 1. Provide equipment and telemetry inside building. Test and verify operation of Station to control tank level. Test telemetry to existing Cameron Tanks No. 1 and 2.

5. Provide Cameron Pump Station No. 2. Provide equipment and telemetry inside building. Test and verify operation of Station to control discharge pressure. Test telemetry to Bodaway-Gap Electrical Substation (provided under separate Contract).

6. Provide Cameron Pump Station No. 3. Provide equipment and telemetry inside building. Test and verify operation of Station to control discharge pressure. Test telemetry to Bodaway-Gap Electrical Substation (provided under separate Contract).

7. Provide telemetry units per details from NTUA Technical Provisions 4.0 for Pump PLC Control Panel.

8. Provide work as specified and per NTUA Standard Drawings and Indian Health Services – Navajo Nation – Standard Drawings.

9. Provide testing per Section 01660, 16030, and 17030.

10. Telemetry PLC and touchscreen programming will be provided by Others. Programmer to program the following and witness testing. Coordinate work, programmers, and provide testing for the following:

    a. Cameron Tank telemetry program modfications and SCADA connection.

    b. Cameron Pump Station No. 1 addition.

    c. Cameron Pump Station No. 2 addition.

    d. Cameron Pump Station No. 3 addition.

    e. Bodaway-Gap Electrical Substation telemetry and SCADA program modification for Pump Station No. 2 and 3.

    f. Bodaway-Gap Tank telemetry and SCADA program modification for Pump Station No. 2 and 3.

11. Equipment to be Owner furnished:

    a. Only that which is labeled as “EXISTING” on drawings.

12. All replaced or removed items shall be salvaged. Salvaged items shall be properly disconnected to retain their full salvage value and cleaned before turning over to the Owner.

13. Work for this system is related to work for the Bodaway-Gap water system, refer to Spec. 01010.

C. DEFINITIONS:

1. SYSTEMS INTEGRATOR: A firm engaged in the business of detailed control system design and engineering, instrumentation component purchase, system and panel assembly, programming, and implementing the specified process control and industrial automation systems.

1.02 QUALITY ASSURANCE

A. REFERENCES:

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. 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 100	Standard Dictionary of Electrical and Electronics Terms
ISA S5.4	Instrument Loop Diagrams
ISA S20	Specification Forms For Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
ISA S51.1	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

B. SYSTEMS INTEGRATOR RESPONSIBILITY:

1. GENERAL

a. The specified control system and instrumentation integration including panel building, instrument calibration, testing, start-up, operational testing, and training shall be performed by a Systems

Integrator staffed with qualified personnel, possessing necessary equipment and experience in performing similar installations.

b. The control system components shall, as far as practical, be of one manufacturer.

c. The components, modules, devices, and control system equipment shall be recognized industrial quality products. Recognized commercial or office grade products are prohibited.

d. The overall system performance shall be demonstrated to and accepted by Owner.

2. SYSTEMS INTEGRATOR QUALIFICATIONS:

a. The following Systems Integrators are pre-qualified to perform the work specified in Division 17 without the need to provide Evidence of Experience:

1) None.

b. Contractor-proposed Systems Integrator shall be evaluated based on submittal of the following Evidence of Experience:

1) Submit evidence of experience in performing three similar successful projects in the last five years with one project currently in progress or competed within the last two years.

2) Submit project descriptions with contact names, addresses, and telephone numbers from the project Owner, General Contractor, and Principal Design Firm.

3). Submit organization chart and resumes for proposed project personnel.

4) Submit 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.

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.

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.

e) Certified training programs, as offered by ISA.

5) Submit financial data for Systems Integrator division when subsidiary to a parent corporation. Include two years of financial data.

a) Financial Statement.

b) Balance Sheet.

c) Dun & Bradstreet Report.

C. PROCESS EQUIPMENT COORDINATION

1. Division 17 specified equipment shall be coordinated for proper operation with equipment related process equipment specified in other Divisions.

2. Equipment shall be integrated, furnished, and installed in conformance with the drawings, specifications, and the recommendations of the equipment manufacturer and the related processes equipment manufacturers.

3. Systems Integrator shall obtain manufacturer's technical information for items of equipment not provided with, but directly connected to, the control system. Provide the necessary coordination and components for correct signal interfaces between specified equipment and the control system.

4. Systems Integrator shall coordinate with project subcontractors and equipment suppliers.

5. Systems Integrator shall provide installation supervision for the duration of the project, a minimum of four man-weeks on-site.

6. Conflicts between the plans, specifications, manufacturer/vendor drawings and installation instructions, etc., shall be presented to the Construction Manager for resolution before proceeding.

1.03 ENVIRONMENTAL CONDITIONS

A. GENERAL:

Specified data communication and process control equipment shall suitable for operation in indoor locations and in outdoor locations. Ambient conditions are specified in Section 01800.

B. CORROSIVE LOCATIONS:

Corrosive locations: None.

1.04 FUNCTIONAL REQUIREMENTS

A. GENERAL:

The instrumentation and control system functions are shown on the drawings and specified in subsequent sections of Division 17. The Systems Integrator drawings and integration practices shall be as defined in IEEE 100, ISA S51.1, and NEMA ICS 1.

1.05 SUBMITTALS

The following information shall be provided in accordance with and Section 01300:

A. SYSTEMS INTEGRATOR QUALIFICATIONS:

1. Systems Integrator Evidence of Experience per paragraph 17000-1.02 B 3. Acceptable review required prior to any other Division 17 submittal.

B. 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 requested 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 for requested deviations from 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-100 through E-130 and Drawing I-001 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 NTUA Technical Provisions 4.0 for PLC Control Panel 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.

4. Nameplate list with material, tag number and description as specified herein.

5. 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. Submit catalog cuts for only the following:

    a. Radio components, and list by location.

    b. Flow meter and indicator.

    c. Flood level switch.

PART 2--PRODUCTS

2.01 GENERAL

A. MATERIALS AND QUALITY:

Equipment material shall be new, free from defects, and industrial-grade, as specified. Each type of instrument, instrument accessory, and device used throughout the work shall be manufactured by one firm, where possible.

Equipment and components shall be as specified on the drawings referenced in Paragraph 1.01 B, and in this Section where not specified on the drawings.

B. RADIO COMPONENTS:

1. Antenna, directional: Kathrein SCALA TY-900, 10 dB Yagi.

2. Antenna, omni-directional: None.

3. Transmission Line: Times Microwave LMR-400 with type N connectors.

4. CommScope Andrews 221213 or 3M 2212 tape kit.

C. FLOW:

1. Flow meter:

a. Refer to NTUA Technical Provisions W-14.

b. Honeywell evoQ4 Electromagnetic with replaceable battery. Factory certified calibration.

c. Honeywell MX 42 VP Module, pulse and Sensus protocol AMI encoder outputs.

d. Honeywell EA_Water 3.0 AMI module, wall mount.

2. Flow indicator:

a. Red Lion PAXI0020, pulse input. Configure for flow rate and total. Provide interposing relay if required between MX 42 pulse output and indicator.

b. Red Lion optional 4-20mA analog output module.

c. NEMA 4 enclosure, minimum 12” x 8” x 6” deep. Nameplate: “DISCHARGE FLOW RATE AND TOTAL”.

D. FLOOD LEVEL SWITCH:

1. NEMA 4X, industrial, protective cage, stainless steel float, magnetic coupling, aluminum switch and terminal housing, Form C contacts. Magnetrol FLS. Connect for normally closed contact, open upon alarm.

2.02 NAMEPLATES

Nameplates shall be provided for all field mounted instrument, analyzer, or equipment specified in Division 17. Nameplate lettering shall include the equipment or instrument loop title and the instrument or equipment tag number, where nameplate engraving is not specified or shown. Nameplates shall be machine engraved black phenolic with white 5/32-inch high lettering, as minimum, unless otherwise specified or shown. Nameplate wording may be changed without additional cost or time, if changes are made prior to commencement of engraving.

Nameplates shall be attached 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. Field instrument namplates shall be attached with braided stainless steel straps where not stand mounted.

2.03 PRODUCT DATA

The following Product Data shall be provided in accordance with Section 01300.

1. Record drawings specified by paragraph 17000-3.03 shall be provided in accordance with Section 01720.

   Provide record drawing prints of all drawings following project start-up, but prior to acceptance of the work showing the final constructed state of the instrumentation and control systems.

2. Operating and maintenance information shall be provided in accordance with Section 01730. Include the following in each Operation and Maintenance manual:

   a. Final reviewed Submittals, including revised as-built record 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.

PART 3--EXECUTION

3.01 INSTALLATION

A. GENERAL:

Equipment shall be installed in locations that are accessible for operation and maintenance services. Equipment not accessible shall be reinstalled at no cost to the Owner.

Installation, calibration, settings, and testing procedures are specified in Section 17000 and subsequent sections of Division 17

B. FIELD EQUIPMENT:

Equipment shall be provided with ports and adjustable items accessible for in-place testing and calibration. 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.

Instruments and cabinets supported by concrete walls shall be spaced 5/8 inch by strut channel between instrument or cabinet and wall. Block wall shall have additional installation supports, as required, to avoid damage to the wall. Equipment supports shall be hot-dip galvanized, 316L stainless steel in chlorine areas.

Support systems including panels shall be designed in accordance with Section 01900 to prevent deformation greater than 1/8 inch in any direction under the attached equipment load and under an external load of 200 pounds.

In wet or outdoor areas, conduit penetrations into instrument housing shall be made 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.

Nameplates shall be provided for all field mounted equipment. Nameplates shall be attached to support hardware with a minimum of two self-tapping Type 316 stainless steel screws in a readily visible location, but such that if the field device is changed out, the nameplate will remain to identify the service.

C. ELECTRICAL POWER CONNECTIONS:

Equipment electric power wiring shall comply with Division 16. Power disconnect switches shall be provided within sight of equipment and labeled to indicate the specific equipment served and the power source location. "Within sight of" is defined as having an unobstructed view from the equipment served and within 50 feet of the equipment served.

D. SIGNAL CONNECTIONS:

Equipment electric signal connections shall be made on terminal blocks or by locking plug and receptacle assemblies. Flexible cable, receptacle and plug assemblies shall be used where shown or specified.

Jacketed flexible conduit shall be used between equipment and rigid raceway systems. Flexible cable assemblies may be used where plug and receptacle assemblies are provided and the installation is not subject to mechanical damage in normal use. The length of flexible conduit or cord assemblies shall not exceed 2 feet.except where sufficient length is required to allow withdrawal of instruments for maintenance or calibration without disconnection of conduit or cord assemblies.

3.02 FIELD TESTS AND INSPECTIONS

A. DELIVERY INSPECTION:

The Contractor shall notify the Owner's Representative upon arrival of any material or equipment to be incorporated into the work. The Contractor shall remove protective covers or otherwise provide access in order that the Owner's Representative may inspect such items.

B. INSPECTION AND INSTALLED TESTS:

Refer to Section 17030 – Process Instrumentation and Control System Testing.

3.03 RECORD DOCUMENTS

Contract document drawings shall be maintained and annotated by the Contractor during construction, including the record drawings specified in Section 16000.

END OF SECTION

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SECTION 17030

PROCESS INSTRUMENTATION AND CONTROL SYSTEM TESTING

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies Contractor and Systems Integrator performance in testing and documentation of process instrumentation and control system materials and equipment (PICS). Additional specific testing has been added to Paragraph 3.03 per Navajo Area Indian Health Service – Technical Provisions for Motor Control Center and Tank Control Panel.

The term instrumentation covers field and panel instruments, primary sensing elements, transmitters, power supplies, and monitoring devices.

Provide the labor, tools, material, power, and services necessary to provide the process instrumentation and control system inspection and testing specified herein. Coordinate all testing with Sections 01660 and 16030:

A. Factory Acceptance Testing (FAT)

B. Pre-Operational Performance Testing Sequence:

1. Telemetry PLC Control Panel
2. Wiring Testing
3. Telemetry Communications
4. Instrumentation Calibration
5. Loop Testing

C. Functional Testing Sequence:

1. Process Control Strategy Testing
2. Control System Closed Loop Commissioning
3. Functional Checkout

D. Operational Testing:

1. System Acceptance Testing (SAT)

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents with additional references listed in Section 17000. All references shall be to the current edition of the document unless specifically stated otherwise. 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 shall prevail. 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, reference 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, reference 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
ISA S51.1	Process Instrumentation Terminology

B. PROJECT LABELING

The items specifying project labeling herein shall include the following as a minimum: Owner's name, facility name, project name, and project number.

1.03 SUBMITTALS

Submittal material, to be submitted in accordance with Section 01300, shall consist of the following:

A. PRE-TESTING SUBMITTAL:

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 requested 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 for requested deviations from 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 01660.

3. Control descriptions per paragraph 17030-2.02 C.

4. I/O Interface Summaries per paragraph 17030-2.02 D.

5. Testing status spreadsheets per paragraph 17030-2.02 A. 3.

6. Test procedures per paragraph 17030-3.01 D.

7. Proposed test forms per PART 3 of this Section 17030, detailed for each test for this project.

8. Certified Factory Calibration Reports for Flow Instruments.

B. FAT:

1. FAT schedule of tests and demonstrations, and location.

PART 2--PRODUCTS

2.01 GENERAL

Provide test forms, documentation, and records as specified in the following paragraphs.

2.02 TESTING DOCUMENTATION

A. NOT USED

B. NOT USED

C. CONTROL DESCRIPTION

Provide a control description outlining operation for each process area's system. The Control Description Specification Section 17900 may be used as a basis.

D. I/O INTERFACE SUMMARY

Provide I/O spreadsheets for each process area's system. Spreadsheets to include the following for each I/O point:

1. Signal number/tag

2. Annotation description that may be logically abbreviated and that is subject to approval.

3. Complete physical I/O channel designation and addressing or communication I/O register designation.

4. True/False status designations for digital I/O.

5. Process range; engineering units and any multipliers; and raw signal range count for analog I/O.

6. 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.

7. Provide Operator Interface scaling to display decimal digits required.

2.03 PRODUCT DATA

Provide the following product data submittal after completion of testing.

The following information shall be provided in accordance with specification Section 01300:

1. Completed test forms per PART 3.

2. List of factory calibrated items and calibration certificates.

3. Record of radio modem readings per PART 3.

PART 3—EXECUTION

3.01 GENERAL

A. GENERAL REQUIREMENTS:

Materials, equipment, and construction included under this specification shall be inspected in accordance with this section and subsequent sections of this division. Testing shall be performed by the Contractor in accordance with this and subsequent sections of this Division.

No required test shall be applied without prior notice to the Construction Manager. Between 60 and 70 days before the commencement of any testing activity, the Contractor shall provide a detailed step-by-step test procedure complete with forms for the recording of test results, testing equipment used, and a place for identification of the individual performing or, if applicable, witnessing the test.

Provide detail assistance to the Contractor in generating form 01660-A, customized for this project. Submit detailed form prior to testing per the requirements of Section 01660.

B. TECHNICIAN QUALIFICATIONS:

Field instruments and analyzers shall be calibrated and set up by a certified instrument technician qualified to calibrate the instrumentation.

Technicians shall be qualified by completion and certification from training courses offered by The Instrumentation, Systems, and Automation Society (ISA), the instrumentation and analyzer manufacturer's training courses, or technician training courses at a recognized trade school that specializes in instrumentation calibration.

C. TEST EQUIPMENT AND MATERIALS:

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.

Test instruments shall have a current calibration sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required. Certified calibration reports traceable to the National Institute of Standards and Technology shall be included with the final test report.

Provide buffer solutions and reference fluids for tests of analytical equipment.

D. FIELD TEST PROCEDURE DOCUMENTATION:

Test procedures submitted for approval within 60 days prior to the start of testing.

Test procedures for each analog and discrete loop in the process control system shall be organized and assembled in separate volumes for each process area. Final test records shall be submitted in electronic form by scanning and converting the records and files to Adobe PDF format, to preserve actual signatures and signoffs.

Test procedure documentation shall 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.

Test report forms for each loop, including forms for wiring, piping, and individual component tests, shall be included with the test procedure documentation. The actual test results shall be recorded on these forms and a final test report assembled as specified in paragraph 17030-3.05.

Test report forms shall be preprinted and completed to the extent possible prior to commencing testing. Test report forms that document the field test procedures shall include the following information:

1. Project name

2. Process area associated with the equipment under test.

3. Instrument loop description.

4. Instrument loop identification number.

5. Instrument nameplate data.

6. Instrument setup and configuration parameters.

7. Time and date of test.

8. Inspection checklist and results.

9. Reference to applicable test procedure.

10. Expected and actual test results for each test point in the loop including programmable controller data table or register values.

11. Test equipment used.

12. Space for remarks regarding test procedure or results, unusual or noteworthy observations, etc.

13. Name, date, and signature of testing personnel.

14. Test witness' name and signature.

E. PERFORMANCE DEVIATION TOLERANCES:

Tolerances shall be specified in Division 17. Where tolerances are not specified, refer to the manufacturer's published performance specifications.

Overall accuracy requirements for loops consisting of two or more components shall be the root-summation-square (RSS) of the component accuracy specifications. Tolerances for each required calibration point shall be calculated and recorded on the associated test report form.

F. INSTALLED TESTS:

Equipment and System Performance and Operational Testing - Section 01660 specifies testing of the mechanical, electrical, instrumentation and HVAC systems. The Contractor's Quality Assurance Manager shall coordinate, manage, and supervise the quality assurance program that includes:

1. Testing plan with the sequence for the test work.

2. Calibration program for all instruments and analyzers.

3. Documentation program that records tests results.

4. Performance testing program systems.

Test forms provided shall conform to the requirements of reference forms 17000-A through 17000-M included in Section 01999. Additional or detailed forms shall be developed as necessary to suit complex instrumentation. Usage of terms used on test forms shall comply with ISA S51.1.

G. WITNESSING:

The Owner reserves the right to observe factory and field instrumentation testing and calibration procedures. The Owner shall be notified prior to testing, as specified herein.

3.02 FACTORY TEST

A. FACTORY ACCEPTANCE TEST (FAT):

1. GENERAL: Control system equipment shall be subject to a Factory Acceptance Test with the factory acceptance tests and subsequent retests witnessed by the

Construction Manager and Owner. Control system panel programmable logic controllers shall be loaded with the PLC software, Operator Interface software and the programming and graphic configuration application software at the control system equipment supplier's factory prior to the FAT.

Equipment, panel instruments, panels, or cabinets shall be inspected with factory testing performed. Provide written notice to the Owner thirty 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.

2. FACTORY ACCEPTANCE TEST PROCEDURES: Panels provided shall be interlocked or networked as applicable, operated, and checked-out by the equipment supplier prior to the FAT. Submit certification indicating that the panels are ready for the FAT.

The FAT shall include the following:

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 shall include:

1) Monitoring state changes on operator interface screens based on the inputs state change.

2) Observation of online PLC programming application software with the associated PLC 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 which do not pass validation.

e. Retest of the FAT at no additional cost.

Panels that pass the FAT may be shipped to the site upon shipping schedule and storage accommodation approval by the Construction Manager.

3.03 PRE-OPERATIONAL PERFORMANCE TESTING

A. GENERAL REQUIREMENTS:

In general, tests shall be performed in the following order:

B. TELEMETRY PLC CONTROL PANEL:

Perform the following, witnessed by the Owner and Programmer. Test form 17000-L:

1. Review dimensions, component layout, and wiring.

2. Examine cabinets and components to determine that specified hardware has been installed.

3. Examine wiring and panel assembly against specification requirements for quality of workmanship.

4. Inventory all panel parts and appropriate documentation.

C. WIRING TESTS:

Electrical power and signal cable ring-out and resistance testing. Conducted in accordance with Sections 16000 and 16030. Wiring tests shall not be conducted until cables have been properly terminated, tagged and inspected.

1. Power and Control: Per Section 16030.

2. Signal: Test form 17000-A.

D. TELEMETRY COMMUNICATIONS:

Perform the following, witnessed by the Owner and Programmer. Test form 17000-M:

1. 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.

2. 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:
        i. Baud Rate = 9600
        ii. Data Bits = 8
        iii. Parity = Even
        iv. Stop Bits = 1

3. 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.

4. Inventory all panel parts and appropriate documentation.

E. INSTRUMENTATION CALIBRATION:

1. Instruments and final elements shall be field calibrated in accordance with the manufacturer's recommended procedures and tested in accordance with the Contractor's test procedure.

2. Individual Component Calibration and Testing shall not commence until Instruments and Component Inspections are completed and documented to the satisfaction of the Owner.

3. Analog instrument calibrated at 0, 10, 50, 90, and 100 percent of the specified full scale range. Each signal sensing trip and process sensing switch shall be adjusted to the required setting. Test data recorded on test forms as specified herein.

4. Final element alignment tested and adjusted to verify that each final element operates smoothly over the full range in response to the specified process control signals.

5. Test data shall be entered on the applicable test forms at the time of testing: Alarm trips, control trips, and switches shall be set to initial values specifiedat this time. Final elements shall be checked for range, dead-band, and speed of response.

6. Any component that fails to meet the required tolerances shall be repaired or replaced by the manufacturer. 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. Test forms 17000-C through 17000-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. Instrument which fail to demonstrate proper performance shall be returned for re-calibration or replaced as agreed depending on the impact to the project as determined by the Construction Manager.

Where instrument field calibration is not feasible, certified factory calibration reports may be submitted that includes 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:

TABLE-A. FACTORY CALIBRATION INSTRUMENT LIST

Instrument Identification	Instrument Section	Description
-	17000	Magnetic flow meter

F. LOOP TESTING:

1. Loop Testing shall not commence until the Individual Component Calibration and Testing has been completed and documented to the satisfaction of the Owner.

2. Each instrument loop shall be tested 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.

Test signals shall be injected at the process impulse line connection where the measuring technique permits, and otherwise at the most primary signal access point.

3. Testing of loops with an interface to a programmable logic controller shall include verification of the programmable logic controller input/output assignment and verification of operation of the input/output system and processor. Inspect the data table or register in the programmable logic controller memory to verify proper operation.

4. If the output control or monitoring device fails to indicate properly, corrections to the loop circuitry or device shall be made. The test shall be repeated until devices and instruments operate as required.

5. Correct loop circuitry and repeat the test until the instruments operate properly.

6. Test form 17000-J.

3.04 FUNCTIONAL TESTING

A. PROCESS CONTROL STRATEGY/FUNCTIONAL TESTING:

1. Control Strategy Testing shall not commence until the Loop Testing has been completed and documented to the satisfaction of the Owner.

2. Control Strategy Testing is performed by the Programmer and Contractor and consist of installing and debugging the PLC control logic program, verifying the interface points between the PLCs and field devices and equipment, and exercising the control strategies. Control Strategy Testing will be performed on one PLC at a time.

3. Provide qualified personnel to immediately correct any 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. Closed-Loop Commissioning shall not commence until the Control Strategy Testing has been successfully completed and documented to the satisfaction of the Owner

2. Closed-loop commissioning tests, performed as part of the system tests, shall demonstrate stable operation of each loop under operating conditions. Tests shall include adjustment of loop tuning parameters.

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. The loop response to a step disturbance shall be provided for each loop. Two graphs shall be made for cascaded control loops, one showing the secondary loop response with its set point in manual, and the second showing overall loop response.

C. FUNCTIONAL CHECKOUT:

Conducted to verify the operation of discrete and hardwired control devices, refer to Section 01660. Exercise the operable devices and energizing the control circuit. Operate control element, alarm device, and interlocks to verify the specified action occurs.

3.05 OPERATIONAL TESTING

System Acceptance Test (SAT) shall be performed after component and subsystem tests have been completed. The test of the completed system shall be performed in full operation and shall demonstrate that all functional requirements of this specification have been met. SAT shall demonstrate the following:

1. Each component of the system operates correctly with all 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. PLC application program performs monitoring and control functions correctly.

6. Operator interface graphics represent the monitoring and control functions correctly.

END OF SECTION

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SECTION 17110

INSTRUMENT AND CONTROL PANELS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies requirements for Telemetry PLC units for the Cameron water system.

Provide Telemetry PLC units as specified in Paragraph 17000-1.01 B. Panels shall be arranged to separate control and instrument devices from power wiring. Panel shall be arranged for dedicated field wiring terminations rated for 600 Vac or less for power, control, and instrument signal wiring shall be fabricated by a UL-508A recognized facility and shall bear the appropriate UL 508A Industrial Control Panel label.

Provide telemetry units per details from NTUA Technical Provisions 4.0 for PLC Control Panel (Booster with BoosterPAQ) drawings.

B. SUBMITTAL DRAWINGS:

1. GENERAL: The drawings included in the project manual are functional in nature and do not show exact locations of equipment or interconnections between equipment. The Contractor's Systems Integrator shall prepare detailed installation drawings as specified below.

Drawings prepared in AutoDesk AutoCAD, or similar with borders and title blocks identifying the project, system, revisions to the drawing, and type of drawing. Each revision of a drawing shall include the date and description of the revisions. Drawing prints shall be 11" x 17" with a minimum lettering size of 1/8".

Diagrams shall carry a uniform and coordinated set of wire numbers and terminal block numbers in compliance with panel wiring and Section 17110, to permit cross-referencing between contract documents and the drawings prepared by the Contractor.

2. CONNECTION DIAGRAMS: Show components of a control panel in an arrangement similar to the actual layout of the panel including internal wiring between devices within the panel. Show terminal blocks used for internal wiring or field wiring, identified as such. Indicate insulation color code, signal polarities, and wire numbers and terminal block numbers.

3. ELEMENTARY OR SCHEMATIC DIAGRAM: Shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. Provide schematics for internal panel power distribution, lighting, and any panel HVAC.

4. ARRANGEMENT, LAYOUT, OR OUTLINE DRAWINGS: Show the dimensioned external and interior control panel views with components and Bill of Material. Provide panel heat load calculations, and indicate cooling or ventilation provisions as required.

5. NETWORK BLOCK DIAGRAM: A network block diagram is a diagram of the overall SCADA system, with annotated boxes to show the primary network components (controllers, hubs, switches, computers, displays), and annotated interconnecting lines that show the system communication media and communication protocols.

1.02 QUALITY ASSURANCE

A. REFERENCES:

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. 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

B. LISTED PRODUCTS:

Equipment and components shall be Underwriters Laboratory (UL) listed for the purpose per Section 16000 or UL recognized.

The control panels shall have factory applied UL 508A labels.

C. FACTORY TESTING:

Prior to shipment, the manufacturer shall test the functional operation of the control panel as described in the control description Section 17030.

D. WARRANTY:

In addition to the guarantee specified in the General Conditions, the equipment, components, and assemblies provided shall be warranted against defects in materials and workmanship of a period of 1 year from the date of completion of all testing specified in Section 17030. Provide warranty service when requested. Provide all costs for transportation, labor, and replacement parts associated with a service call required under the warranty. Cost reimbursement will be provided for the service call and any repair work if it is determined that the control system was damaged by vandalism or an Act of God. Cost reimbursement will also be made if the call was due to a non-functioning device which was not part of the Contract installation, or for blown fuses or tripped circuit breakers.

E. TELEMETRY PLC DRAWINGS:

1. Drawings:

a. Cover sheet with site name.

b. Discrete I/O wiring.

c. Analog I/O wiring.

d. Power Distribution.

e. Backplane layout with bill of materials.

f. Communication cable pinouts.

g. Nameplate list with material, color, tag number, and description.

h. Above drawings modified for this project, include added surge tank differential pressure/level signal for Pump Station No. 2 and No. 3 and flood level switch for all pump stations.

1.03 SUBMITTALS

Submittals and transmittal procedures for submittals are defined in Section 01300. Submit In accordance with the procedures set forth in Section 01300 that include drawings, information and technical data for equipment and as required in Section 17000. Submittal information shall be included in one complete submittal.

A. 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.

2. A marked copy of specification section 17000.

3. A copy of the contract document Electrical Drawings E-101 through E-130 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. A copy of the contract document Instrumentation Drawing I-001 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 NTUA Technical Provisions 4.0 for PLC Control Panel (Booster with BoosterPAQ) 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.

6. 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. Submit catalog cuts for the following:

    a. Radio components.

    b. PLC and modules.

    c. Touchcreen.

    d. Power supplies.

    e. SCADA Network components.

7. Manufacturer’s installation manual excerpts, as to be used for this project:

    a. Installation details/drawings.

    b. Electrical connection diagrams

    c. Calibration procedures.

8. Telemetry PLC drawings and diagrams generated in CAD for the telemetry equipment specified in paragraph 1.02 E. similar to those included in the drawings.

9. SCADA Network Cabinet drawings generated in CAD:

    a. Backplane layout with bill of materials.

    b. Block diagram of components and interconnections.

    c. Power distribution schematic diagram.

10. List of miscellaneous items, cables, spare and replenishment parts.

11. Nameplate engraving schedule:

a. Indicate engraving by line

b. Character size

c. Nameplate size

d. Panel and equipment tag number and description

1.04 ENVIRONMENTAL CONDITIONS

Refer to Section 17000.

PART 2--PRODUCTS

2.01 FABRICATION

A. GENERAL:

Panels shall be designed for the seismic requirements of Section 17000. Structures, equipment, and devices shall be braced to prevent damage from specified forces. Equipment panels shall be capable of operation following a disturbance.

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.

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.

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.

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.

2.02 PANEL AND COMPONENTS

Equipment material shall be new, free from defects, and industrial-grade, as specified. Each type of equipment, component, accessory, and device used throughout the work shall be manufactured by one firm, where possible.

Equipment and components shall be as specified on the drawings referenced in Paragraph 1.01 A, and in this Section where not specified on the drawings.

2.03 NOT USED

2.04 NAMEPLATES

External door-mounted components and the panel description shall be identified with plastic nameplates. Machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

The machine engraved laminated black phenolic nameplates with white lettering shall be provided for panel-mounted equipment. Nameplate engraving shall include the instrument tag number and description in 3/32-inch minimum size lettering.

The machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

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 stainless steel panels.

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 NFPA No. 70 Type MTW No. 18 AWG minimum, with an exception for factory supplied PLC wiring harnesses that are U.L. approved.

2. Panel instrument wiring: Twisted No. 18 AWG shielded pair or tri conductors.

3. Panel power wiring: Conductors specified in Division 16 and meet the NFPA No. 70 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. Wiring channel fill shall not exceed 50 percent.

B. CONDUCTOR IDENTIFICATION:

Wiring shall be tagged at terminations with machine printed plastic sleeves with three-part wire numbers for instrument and control panel internal conductors:

1. Part-1: Prefix of the wire number shall be the instrument loop number or equipment tag number.

2. Part-2: Code letter and wire colors per the following tables.

3. 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	24 Vdc 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:

Field wiring shall be connected to separate dedicated terminal blocks in a dedicated part of the panel where the field cables enter the panel.

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:

120 Vac control power source: Single power source for all control and DC power.

1. Provide direct current power supplies, as required for the load.

G. NOT USED

H. ACCESSORIES:

1. Include GFCI convenience receptacle.

2. Print pocket.

2.06 SURGE PROTECTION

Surge protectors shall be as specified on Drawings.

2.07 PANEL GROUNDING

A. Provide as specified on Drawings.

B. 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.

2.08 PANEL DRAWING PROTECTION

Provide wiring diagrams in accordance with Section 01300. Provide a panel-wiring diagram and schematic for each panel in a plastic bag or plastic container to avoid water damage and aging.

2.09 RADIO COMPONENTS

1. Radio: Provide GE MDS Trans-NET EL805-MD9X1AFCS0WN, spread-spectrum 928/952 MHz.

2. Transmission Line: Times Microwave LMR-300, 3', with type N connectors.

3. Radio to PC configuration cable, GE MDS 03-3246A01. Provide one for the entire system.

2.10 SCADA NETWORK 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-OBM23-ODC0-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.

6. Freestanding pad-lockable NEMA 4 Cabinet, front and rear access, air conditioner, Sun West Engineering Z-5G-LTE-SM-MO1734.

7. Provide the above completely assembled, with interconnecting Ethernet cables and power connections. Generate layout drawings per paragraph 1.01 B. and submit.

2.11 SPARE PARTS

The following spare parts shall be provided:

1. Five each of each type and rating of fuse used in the panels.

2.12 PRODUCT DATA

The following data shall be provided in accordance with Section 01300:

1. Manufacturer's operation and maintenance information as specified in Section 17000 including final reviewed submittal and as-built drawings.

2. Test results as specified in Section 17030-Part 2.

PART 3--EXECUTION

3.01 GENERAL

All conduit shall enter the panels from the bottom. Provide Myers hub for ridig steel conduit entry.

Field panels and cabinets shall be mounted in compliance with paragraph 17000-3.01 B.

Provide panels with the As-built schematic, connection, and interconnection diagrams located in a print pocket on the inside of the door. Place documentation in a water proof clear bag in the panel document holder.

3.02 NOT USED

3.03 PANEL POWER SUPPLY

Power supply and conditioning equipment shall be mounted and connected in compliance with the manufacturer's instructions.

Final raceway connections shall be conduit in compliance with Division 16.

3.04 FACTORY TESTING

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

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. Signal and control wiring installed in separate wireways.

4. Barriers between the power wiring and the signal and control wiring.

5. Connected to the plant grounding system, as specified.

6. Center-line of wall-mounted panels shall be 48 inches above the floor.

7. Inner door contains a copy of the as-built elementary and wiring diagrams.

8. Inner door contains a protected drawing holder.

9. Drawings enclosed in a transparent, protective jacket.

10. Functions as specified.

11. Mounted with unistrut, fittings, and fasteners as specified.

12. Tested in accordance with Section 16030 and Section 17030.

END OF SECTION

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SECTION 17900

CONTROL SPECIFICATIONS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies the control specification strategies for modifications to the Navajo Nation Cameron Water System that are based on Programmable Logic Controller (PLC) based Telemetry systems.

Telemetry System Programming and Touchscreen Graphics Development responsibilities: Refer to Section 17000.

The Control Specification strategies describe sequential and interlocking control functions, analog control functions, and color-graphic video display operator interfaces including alarm and event logging. The generic term used herein shall be Telemetry.

The Contractor shall provide all necessary labor and equipment to test the control strategies per Section 17030.

B. WATER SYSTEM:

Refer to the General Notes on Drawing I-001 for a brief overview of the water system control requirements.

PART 2—PRODUCTS – NOT USED

PART 3--EXECUTION

3.01 STANDARD INTERLOCKS

Interlocks (I) shutdown and prevent equipment from operating:

1. Hardwired interlocks are effective whether the PLC system is in operation or not, and in hand and auto modes unless noted.

2. Software interlocks are provided by the PLC, and are usually only effective when the equipment is operating in auto mode unless noted.

The following describe general interlock features for all systems:

I1 – MOTOR PROTECTION

Equipment motor protection includes overload and/or VFD or RVSS fault or Motor Protection Relay alarm, hardwired only. Manual reset required at the starter, VFD, or RVSS.

3.02 STANDARD GENERAL CONTROL STRATEGIES

Control Strategies (CS) define common equipment operations performed by the PLC and displayed by the Telemetry system. Hardwired control strategies are effective for equipment control whether the PLC system is in operation or not, and in hand and auto modes unless noted.

Control Strategies unique to each process system are defined beginning in paragraph 3.10 below. The following describe general control features for all systems:

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.

TELEMETRY: 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.

TELEMETRY: Display total in kGal or MGal as shown on P&ID.

Previous 24 hour day flow totalization will also be calculated and maintained by the PLC.

TELEMETRY: Summary display of previous day totals 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. PLC alarm setpoints are provided in paragraph 17200-3.03 instrument index.

TELEMETRY: Display alarms. Display active and cleared-but-unacknowledged alarms in the alarm summary.

CS7 - PROCESS ALARM(S), MANUAL RESET FROM TELEMETRY 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.

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 reset by the Telemetry 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, if any, are provided in paragraph 17900-3.03.

TELEMETRY: Display alarms. Display active and cleared-but-unacknowledged alarms in the alarm summary. Telemetry allows Operator reset of alarms.

CS9 - DISCRETE POINT STATUS

The status of each discrete input point will be maintained in the PLC.

The status of each logical discrete point will also be maintained in the PLC. Logical points are points which depend upon the status of one or several discrete input points.

TELEMETRY: 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. Where the PLC module cannot read outside the 4-20 mA range, use discrete alarm bits available from the module or PLC status function block.

TELEMETRY: Display alarm. Display active and cleared-but-unacknowledged alarm in the alarm summary

CS11 - GENERAL EQUIPMENT DISCREPANCY

The failure of driven equipment to respond will be monitored by the Telemetry system. Equipment will be considered to be in discrepancy under the following conditions:

1. The equipment is in AUTO and the Telemetry system attempts to operate the equipment and it does not respond within a defined time period, typically 15 seconds.

2. The equipment is in AUTO and running and for whatever reason other than the Telemetry system requesting the equipment to "STOP," the equipment stops.

CS12 - TELEMETRY INPUTS AND OUTPUTS STATUS

The PLC will monitor status of each individual input, output, and communication module, and all processor statuses available.

TELEMETRY: 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.

CS16 - TREND PLOTS

TELEMETRY workstations will graphically plot trends of all process variables (pressure, flow, temperature, level, analytical, electrical kW and Power Factor) in real-time and from historical data. 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.
7. Range and units

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 with high performance graphics to identify status as tabulated below:

Equipment	Status	Required color
Motor	Running	Green
Motor	Ready or Off	Red
Valve	Opened position	Green
Valve	Closed position	Red
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).

TELEMETRY: Display alarms. Display active and cleared-but-unacknowledged alarms in the alarm summary.

CS19 - DATA ARCHIVING HISTORIAN AND HISTORICAL FUNCTIONS

None. These are provided by the separate Regional SCADA System.

CS20 - DIGITAL STATUS SYSTEM

All digital input status will be displayed on Telemetry 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 PLCs AND THE TELEMETRY SYSTEM

Digital inputs and analog inputs to the Telemetry system and the software logic generated alarms will be displayed or annunciated at the Telemetry touchscreen as specified on the Drawings and in this Section.

The Telemetry system will generate separate alarms if communication is lost with any PLC.

Data displayed on the Telemetry installed on this project shall be made available to the existing Regional SCADA System.

For Cameron Pump Station No. 1, the Regional SCADA System RTU shall be located at the existing Cameron Tanks No. 1 and 2.

For Cameron Pump Station No. 2 and No. 3, the existing Regional SCADA System RTU is located at the existing Bodaway-Gap Tank, with signals relayed via the existing Bodaway-Gap Electrical Substation.

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.

3.03 CONTROL STRATEGY – CAMERON TANK LEVEL

A. P&ID: I-001

B. GENERAL DESCRIPTION:

The existing Tanks (2) level are maintained by existing Wells 1 and 2 (emergency use only due to water quality issues) and Pump Station No. 1 providing water from the Bodaway-Gap system.

C. CONTROL STRATEGY OVERVIEW:

The existing Tank Telemetry PLC periodically requests via radio the status and alarm data, and sends the tank level signal to Pump Station No. 1 Telemetry PLCs.

Pump Station No. 1 has two pumps, one is duty and one is standby. Start/stop level setpoints for pump 1 or 2 is Operator adjustable at the Pump Station No. 1 Telemetry PLC Touchscreen. Pump speed is controlled to maintain discharge pressure by the pump management unit. Pumps alternate when the duty pump stops.

Open/close level setpoints for the pump bypass line solenoid valve are Operator adjustable at Pump Station No. 1 Telemetry PLC Touchscreen. The reason for the bypass valve is if the pumps are offline. The tank will instead be filled by the opening of the solenoid valve at ½ the rate of the pumps. Once the tank is full, the solenoid valve will close.

D. LOCAL CONTROL:

1. Field - Tank:

   Mechanical Level indication

2. Field - Pump Station:

   Discharge Pressure indication
   Discharge Flow indication

3. Pumps VFD:

   HAND-OFF-AUTO selector
   Keypad

4. Interlocks per 17900-3.01:

   I1 – MOTOR PROTECTION

E. REMOTE OR AUTOMATIC CONTROL:

1. Control Strategy, per above and including:

CS1 - EQUIPMENT RUN TIME TOTALIZATION
CS2 - FLOW TOTALIZATION
CS11 - GENERAL EQUIPMENT DISCREPANCY
CS16 - TREND PLOTS
CS51 – ALTERNATION

2. Software Interlocks per 17900-3.01: None.

3. TELEMETRY - TANK:

Tank Level indication
Touchscreen indication of Telemetry from the existing Wells
Touchscreen indication of Telemetry from Pump Station No. 1

4. TELEMETRY – PUMP STATION NO. 1:

RUN status
VFD FAULT alarm
VFD HIGH TEMPERATURE alarm
VFD OVERCURRENT alarm
AUTO status
Pump Motor Amps indication
Flow and Total indication
Pump Station Flood Level alarm
Tank Level indication
OPEN/CLOSE control status

5. TELEMETRY – FOR REGIONAL SCADA:

The above Telemetry signals are all made available to the Cameron Tanks Telemetry PLC for Ethernet access by the Regional SCADA RTU.

3.04 CONTROL STRATEGY – PUMP STATION NO. 2 PRESSURE

A. P&ID: I-001

B. GENERAL DESCRIPTION:

The area system pressure is maintained by Pump Station No. 2.

C. CONTROL STRATEGY OVERVIEW:

Pump Station No. 2 has two pumps, one is duty and one is standby. Start/stop pressure setpoints for pump 1 or 2 is Operator adjustable at the Pump Station Telemetry PLC Touchscreen. Pump speed is controlled to maintain discharge pressure by the pump management unit. Pumps alternate when the duty pump stops.

The hydropneumatic tank level measurement is monitored using differential pressure measurement of the pressure at the top of the tank and the pressure at the bottom which would also include the hydrostatic head level of the water in the tank. A high level alarm is determined by the Telemetry PLC, which would indicate that the internal tank bladder has insufficient air charge pressure, or is ruptured.

D. LOCAL CONTROL:

1. Not used.

2. Field – Pump Station:

   Discharge Pressure indication
   Discharge Flow indication
   Hydropneumatic Tank Level indication

3. Pump VFD:

   HAND-OFF-AUTO selector
   Keypad

4. Interlocks per 17900-3.01:

   I1 – MOTOR PROTECTION

E. REMOTE OR AUTOMATIC CONTROL:

1. Control Strategy, per above and including:

   CS1 - EQUIPMENT RUN TIME TOTALIZATION
   CS2 - FLOW TOTALIZATION
   CS11 - GENERAL EQUIPMENT DISCREPANCY
   CS16 - TREND PLOTS
   CS51 – ALTERNATION

2. Software Interlocks per 17900-3.01: None.

3. Not used.

4. TELEMETRY - PUMP STATION:

RUN status
VFD FAULT alarm
VFD HIGH TEMPERATURE alarm
VFD OVERCURRENT alarm
AUTO status
Pump Motor Amps indication
Hydropneumatic Tank Level indication
Flow and Total indication
Pump Station Flood Level alarm

5. TELEMETRY – FOR REGIONAL SCADA:

The above Telemetry signals are all forwarded via the existing Bodaway-Gap Electrical Substation Telemetry PLC to the existing Bodaway-Gap Tank Telemetry PLC for Ethernet access by the Regional SCADA RTU.

3.05 CONTROL STRATEGY – PUMP STATION NO. 3 PRESSURE

A. P&ID: I-001

B. GENERAL DESCRIPTION:

The area system pressure is maintained by Pump Station No. 3.

C. CONTROL STRATEGY OVERVIEW:

Pump Station No. 3 has two pumps, one is duty and one is standby. Start/stop pressure setpoints for pump 1 or 2 is Operator adjustable at the Pump Station Telemetry PLC Toucschreens. Pump speed is controlled to maintain discharge pressure by the pump management unit. Pumps alternate when the duty pump stops.

The hydropneumatic tank level measurement is monitored using differential pressure measurement of the pressure at the top of the tank and the pressure at the bottom which would also include the hydrostatic head level of the water in the tank. A high level alarm is determined by the Telemetry PLC, which would indicate that the internal tank bladder has insufficient air charge pressure, or is ruptured.

D. LOCAL CONTROL:

1. Not used.

2. Field – Pump Station:

Discharge Pressure indication
Discharge Flow indication

Hydropneumatic Tank Level indication

3. Pump VFD:

   HAND-OFF-AUTO selector
   Keypad

4. Interlocks per 17900-3.01:

   I1 – MOTOR PROTECTION

E. REMOTE OR AUTOMATIC CONTROL:

1. Control Strategy, per above and including:

   CS1 - EQUIPMENT RUN TIME TOTALIZATION
   CS2 - FLOW TOTALIZATION
   CS11 - GENERAL EQUIPMENT DISCREPANCY
   CS16 - TREND PLOTS
   CS51 – ALTERNATION

2. Software Interlocks per 17900-3.01: None.

3. Not used.

4. TELEMETRY - PUMP STATION:

   RUN status
   VFD FAULT alarm
   VFD HIGH TEMPERATURE alarm
   VFD OVERCURRENT alarm
   AUTO status
   Pump Motor Amps indication
   Hydropneumatic Tank Level indication
   Flow and Total indication
   Pump Station Flood Level alarm

5. TELEMETRY – FOR REGIONAL SCADA:

   The above Telemetry signals are forwarded via the Bodaway-Gap Electrical Substation Telemetry PLC to the existing Bodaway-Gap Tank Telemetry PLC for Ethernet access by the Regional SCADA RTU.

END OF SECTION

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