



NTUA WASTEWATER TREATMENT PLANT UPGRADE

TECHNICAL SPECIFICATIONS NAVAJO TRIBAL UTILITY AUTHORITY



Smith Engineering Company
2201 San Pedro Drive NE,
Building 4, Suite 200
Albuquerque, NM 87110
(505) 884-0700
www.smithengineering.pro

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NTUA WASTEWATER TREATMENT PLANT UPGRADE

TECHNICAL SPECIFICATIONS NAVAJO TRIBAL UTILITY AUTHORITY

ENGINEER CERTIFICATION

PROJECT NAME: NTUA Wastewater Treatment Plant Upgrades

LOCATION: Chinle, Arizona
Pinon, Arizona
Kayenta, Arizona
Ganado, Arizona
Tuba City, Arizona

ENGINEER OF RECORD: Allena Muskett, PE
Smith Engineering Company
2201 San Pedro NE, Building #4, Suite 200
Albuquerque, New Mexico 87110

The technical material and data contained in the specifications were prepared under the supervision and direction of the undersigned, whose seal as a Professional Engineer, licensed to practice in the state of Arizona, is affixed below.

Allena Muskett, PE Date
AZ License No. 54300, EXPIRES 12/31/2018



TECHNICAL SPECIFICATIONS

ALL WORK DETAILED IN THIS PROJECT IS TO BE PERFORMED, EXCEPT AS OTHERWISE STATED IN THE SUPPLEMENTARY SPECIFICATIONS WHICH IS PROVIDED HEREIN, IN ACCORDANCE WITH THE MARICOPA ASSOCIATION OF GOVERNMENT (MAG) UNIFORM STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION- 2011 EDITION (REFERRED TO HEREIN BY STD. SPEC NUMBER OR STD. DWG NUMBER).

A FREE COPY OF THE MAG SPECS IS AVAILABLE AT
[HTTP://WWW.AZMAG.GOV/DOCUMENTS/2011_SPECIFICATIONS_BOOK.PDF](http://www.azmag.gov/documents/2011_specifications_book.pdf)

SUPPLEMENTAL SPECIFICATIONS

SECTION	NAME
DIVISION 1 - GENERAL	
01 11 00	SUMMARY OF WORK
01 21 00	ALLOWANCES
01 21 19	TESTING AND QUALITY ASSURANCE
01 29 76	APPLICATION FOR PAYMENT
01 33 00	SUBMITTAL PROCEDURES
01 57 23	TEMPORARY POLLUTION CONTROL
01 64 00	OWNER SUPPLIED PRODUCTS
01 71 33	WORK SEQUENCE
01 73 19	INSTALLATION OF WASTEWATER TREATMENT FACILITY EQUIPMENT
01 74 23	CLEANING
01 77 23	OPERATION AND MAINTENANCE DATA
01 78 39	PROJECT RECORD DOCUMENTS

SECTION	NAME
DIVISION 2 - SITE CONSTRUCTION	
02 41 00	DEMOLITION

SECTION	NAME
DIVISION 3 - CONCRETE	
03 12 00	CONCRETE FRAMEWORK
03 21 13	REINFORCING STEEL
03 30 00	CAST IN PLACE CONCRETE



SECTION	NAME
DIVISION 4 - MASONRY	
04 05 16	MASONRY GROUTING
04 05 23	MASONRY ACCESSORIES
04 20 00	UNIT MASONRY
04 22 35	REINFORCED BLOCK MASONRY

SECTION	NAME
DIVISION 7 - THERMAL & MOISTURE PROTECTION	
07 92 00	JOINT SEALANTS
07 95 01	EXPANSION JOINT SEALANT

SECTION	NAME
DIVISION 16 - ELECTRICAL SPECIFICATIONS CHINLE	
16010	BASIC ELECTRICAL REQUIREMENTS
16110	RACEWAYS
16120	WIRES AND CABLES (600v OR LESS)
16130	BOXES
16140	WIRING DEVICES
16195	ELECTRICAL IDENTIFICATION
16250	DIESEL ENGINE GENERATOR
16260	AUTOMATIC TRANSFER SWITCH
16401	SERVICE ENTRANCE SECTION
16450	GROUNDING
16470	PANELBOARDS
16475	OVERCURRENT PROTECTIVE DEVICES
16480	MINI POWER CENTERS
16481	MOTOR CONTROLLERS
16500	LIGHTING



SECTION	NAME
DIVISION 16 - ELECTRICAL SPECIFICATIONS PINON	
16010	BASIC ELECTRICAL REQUIREMENTS
16110	RACEWAYS
16120	WIRES AND CABLES (600v OR LESS)
16130	BOXES
16140	WIRING DEVICES
16195	ELECTRICAL IDENTIFICATION
16250	DIESEL ENGINE GENERATOR
16260	AUTOMATIC TRANSFER SWITCH
16401	SERVICE ENTRANCE SECTION
16450	GROUNDING
16470	PANELBOARDS
16475	OVERCURRENT PROTECTIVE DEVICES
16480	MINI POWER CENTERS
16500	LIGHTING

SECTION	NAME
DIVISION 16 - ELECTRICAL SPECIFICATIONS KAYENTA	
16010	BASIC ELECTRICAL REQUIREMENTS
16110	RACEWAYS
16120	WIRES AND CABLES (600v OR LESS)
16130	BOXES
16140	WIRING DEVICES
16195	ELECTRICAL IDENTIFICATION
16250	DIESEL ENGINE GENERATOR
16260	AUTOMATIC TRANSFER SWITCH
16400	FREE STANDING SERVICE ENTRANCE SECTION
16401	WALL MOUNTED SERVICE ENTRANCE SECTION
16425	DISTRIBUTION SWITCHBOARDS
16450	GROUNDING
16461	TRANSFORMERS (DRY-TYPE)
16470	PANELBOARDS
16475	OVERCURRENT PROTECTIVE DEVICES
16500	LIGHTING



SECTION	NAME
DIVISION 16 - ELECTRICAL SPECIFICATIONS GANADO	
16010	BASIC ELECTRICAL REQUIREMENTS
16110	RACEWAYS
16120	WIRES AND CABLES (600v OR LESS)
16130	BOXES
16140	WIRING DEVICES
16195	ELECTRICAL IDENTIFICATION
16250	DIESEL ENGINE GENERATOR
16260	AUTOMATIC TRANSFER SWITCH
16400	FREE STANDING SERVICE ENTRANCE SECTION
16401	WALL MOUNTED SERVICE ENTRANCE SECTION
16425	DISTRIBUTION SWITCHBOARDS
16450	GROUNDING
16461	TRANSFORMERS (DRY-TYPE)
16470	PANELBOARDS
16475	OVERCURRENT PROTECTIVE DEVICES
16500	LIGHTING

SECTION	NAME
DIVISION 16 - ELECTRICAL SPECIFICATIONS TUBA CITY	
16010	BASIC ELECTRICAL REQUIREMENTS
16110	RACEWAYS
16120	WIRES AND CABLES (600v OR LESS)
16130	BOXES
16140	WIRING DEVICES
16195	ELECTRICAL IDENTIFICATION
16261	MANUAL TRANSFER SWITCH
16400	FREE STANDING SERVICE ENTRANCE SECTION
16425	DISTRIBUTION SWITCHBOARDS
16450	GROUNDING
16461	TRANSFORMERS (DRY-TYPE)
16470	PANELBOARDS
16475	OVERCURRENT PROTECTIVE DEVICES
16500	LIGHTING



SECTION	NAME
DIVISION 31 - EARTHWORK	
31 05 19	GEOGRID FOR EARTHWORK
31 20 00	EARTHWORK
31 55 00	EARTH RETENTION

SECTION	NAME
DIVISION 33 - UTILITIES	
33 31 15	LARGE DIAMETER PLASTIC SEWER PIPE

SECTION	NAME
DIVISION 35 – WATERWAY CONSTRUCTION	
35 20 16	HYDRAULIC SLUICE GATE



STANDARD SPECIFICATIONS

MARICOPA ASSOCIATION OF GOVERNMENT (MAG) UNIFORM STANDARD SPECIFICATIONS FOR PUBLIC WORKS
CONSTRUCTION- 2011 EDITION

A FREE COPY OF THE MAG SPECS IS AVAILABLE AT
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PART 200 - EARTHWORK

Section (Last Revised)	Title Page
201 (1999) Clearing and Grubbing	201-1
205 (1998) Roadway Excavation	205-1
206 (2008) Structure Excavation and Backfill	206-1
210 (2009) Borrow Excavation	210-1
211 (1998) Fill Construction	211-1
215 (1998) Earthwork for Open Channels	215-1
220 (2010) Riprap Construction	220-1
225 (1998) Watering	225-1
230 (2010) Dust Palliative Application	230-1

PART 300 - STREETS AND RELATED WORK

Section (Last Revised)	Title Page
301 (2009) Subgrade Preparation	301-1
306 (2010) Mechanically Stabilized Subgrade- Geogrid Reinforcement	306-1
309 (2000) Lime Slurry Stabilization	309-1
310 (2011) Untreated Base	310-1
311 (2000) Soil Cement Base Course	311-2
312 (1999) Cement Treated Base	312-1
313 (1999) Bituminous Treated Base Course	313-1
315 (1998) Bituminous Prime Coat	315-1
317 (2011) Asphalt Milling	317-1
320 (1999) Road-mixed Surfacing	320-1
321 (2011) Asphalt Concrete Pavement	321-1
Section (Last Revised)	Title Page
323 (2010) Heater Remix Resurfacing	323-1
324 (1998) Portland Cement Concrete Street Pavement	324-1
325 (2009) Asphalt-Rubber Concrete Overlay, GAP Graded	325-1
327 (1998) Hot in-Place Recycling	327-1
329 (1998) Tack Coat	329-1
330 (1998) Asphalt Chip Seal	330-1
331 (2009) Microsurfacing Specifications	331-1
332 (1999) Asphalt Emulsion Slurry Seal Coat	332-1



333 (1998) Fog Seal Coats	333-1
334 (1998) Preservative Seal for Asphalt Concrete	334-1
335 (1998) Hot Asphalt-rubber Seal	335-1
336 (2011) Pavement Matching and Surfacing Replacement	336-1
340 (2011) Concrete Curb, Gutter, Sidewalk, Sidewalk Ramps, Driveway and Alley Entrance	340-1
341 (1998) Terrazzo Sidewalks	341-1
342 (2005/2006) Decorative Pavement Concrete Paving Stone or Brick	342-1
343 (1998) Exposed Aggregate Paving	343-1
345 (2009) Adjusting Frames, Covers, Valve Boxes and Water Meter Boxes	345-1
350 (2004) Removal of Existing Improvements	350-1
355 (2011) Utility Potholes-Keyhole Method	355-1
360 (1998) Telecommunications Installation	360-1

PART 400 - RIGHT-OF-WAY AND TRAFFIC CONTROL

Section (Last Revised)	Title Page
401 (1998) Traffic Control	401-1
405 (1998) Monuments	405-1
410 (1998) Precast Safety Curbs	410-1
415 (1998) Flexible Metal Guardrail	415-1
420 (1998) Chain Link Fences	420-1
424 (1998) Parkway Grading	424-1
425 (1998) Topsoils	425-1
430 (1998) Landscaping and Planting	430-1
440 (1999) Sprinkler Irrigation System Installation	440-1

PART 500 - STRUCTURES

Section (Last Revised)	Title Page
501 (1998) Driving Piles	501-1
505 (2010) Concrete Structures	505-1
506 (1998) Precast Prestressed Concrete Members	506-1
510 (1998) Concrete Block Masonry	510-1
511 (1998) Brick Masonry	511-1
515 (1998) Steel Structures	515-1
520 (1998) Steel and Aluminum Handrails	520-1
525 (1998) Pneumatically Placed Mortar	525-1
530 (2000) Painting	530-1

PART 600 - WATER AND SEWER

Section (Last Revised)	Title Page
601 (2009) Trench Excavation, Backfilling and Compaction	601-1
602 (1998) Encasement of Water or Sewer Pipe by Jacking or Tunneling Operation	602-1
603 (2009) Installation for High Density Polyethylene Pipe	603-1
604 (2011) Placement of Controlled Low Strength Material	604-1
605 (1998) Subdrainage	605-1



610 (2011) Water Line Construction	610-1
611 (2011) Disinfecting Water Mains	611-1
615 (2007) Sewer Line Construction	615-1
616 (2002) Reclaimed Water Line Construction	616-1
618 (2011) Storm Drain Construction	618-1
620 (1998) Cast-in-place Concrete Pipe	620-1
621 (1998) Corrugated Metal Pipe and Arches	621-1
625 (2007) Manhole Construction and Drop Sewer Connections	625-1
630 (2010) Tapping Sleeves, Valves and Valve Boxes on Water Lines	630-1
631 (2008) Water Taps and Meter Service Connections	631-1

PART 700 - MATERIALS

Section (Last Revised)	Title Page
701 (2010) Rock, Gravel, and Sand	701-1
702 (2011) Base Materials	702-1
703 (2010) Riprap	703-1
705 (1998) Portland Cement Treated Base	705-1
708 (2011) Asphalt Pavement Core Bonding Materials	708-1
709 (2009) Reclaimed Asphalt Pavement	709-1
710 (2009) Asphalt Concrete	710-1
711 (2003) Paving Asphalt	711-1
712 (1999) Liquid Asphalt	712-1
713 (1998) Emulsified Asphalts	713-1
714 (2009) Microsurfacing Materials	714-1
715 (2010) Slurry Seal Materials	715-1
716 (1998) Cover Material	716-1
717 (1998) Asphalt-rubber	717-1
718 (2004) Preservative Seal for Asphalt Concrete	718-1
719 (1998) Recycled Asphalt Concrete Hot Mixed	719-1
725 (2010) Portland Cement Concrete	725-1
726 (1998) Concrete Curing Materials	726-1
727 (2008) Steel Reinforcement	727-1
728 (2011) Controlled Low Strength Material	728-1
729 (1998) Expansion Joint Filler	729-1
735 (2008) Reinforced Concrete Pipe	735-1
736 (1998) Non-Reinforced Concrete Pipe	736-1
737 (1998) Asbestos-Cement Pipe and Fittings for Storm Drain and Sanitary Sewer	737-1
738 (2004) High Density Polyethylene Pipe & Fittings for Storm Drain & Sanitary Sewer	738-1
741 (2011) Lining for Reinforced Concrete Sanitary Sewer Pipe	741-1
743 (1998) Vitrified Clay Pipe	743-1
744 (1998) ABS Truss Pipe and Fittings	744-1
745 (1998) PVC Sewer Pipe and Fittings	745-1
750 (2005) Iron Water Pipe and Fittings	750-1
752 (1998) Asbestos-Cement Water Pipe and Fittings	752-1



753 (2000) Galvanized Pipe and Fittings	753-1
754 (1998) Copper Pipe, Tubing and Fittings	754-1
755 (1998) Polyethylene Pipe for Water Distribution	755-1
756 (2008) Dry Barrel/Fire Hydrants	756-1
757 (1998) Sprinkler Irrigation System	757-1
758 (2005) Concrete Pressure Pipe - Steel Cylinder Type	758-1
759 (2002) Steel Pipe	759-1
760 (1998) Coating Corrugated Metal Pipe and Arches	760-1
761 (1998) Structural Plate Pipe, Arches, and Pipe Arches	761-1
770 (2000) Structural and Rivet Steel, Rivets, Bolts, Pins, and Anchor Bolts	770-1
771 (2005) Galvanizing	771-1
772 (2000) Chain Link Fence	772-2
775 (1999) Brick and Concrete Masonry Units (Blocks)	775-1
776 (1998) Masonry Mortar and Grout	776-1
778 (1998) Lumber	778-1
779 (1998) Wood Preservatives	779-1
780 (1998) Timber Piles	780-1
781 (1998) Steel Piles	781-1
782 (1998) Concrete Piles	782-1
785 (1998) Steel Castings	785-1
786 (1998) Bronze Castings	786-1
787 (1999) Gray Iron Castings	787-1
790 (1999) Paint	790-1
792 (2010) Dust Palliative	792-1
795 (1998) Landscape Material	795-1



SUPPLEMENTAL SECTION 01 11 00

SUMMARY OF WORK

PART 1: GENERAL

1.0 SUMMARY

A. The Work of this Contract is located at three different locations.

1. The first is Chinle, Arizona on the Navajo Nation (Navajo Tribal Reservation). Chinle WWTP is approximately 2 miles north of Chinle on the east side of AZ State Road 191 from the intersection of AZ St RD 191 and Indn Route 7.
2. The second site is Pinon, Arizona on the Navajo Nation (Navajo Tribal Reservation). Pinon WWTP is approximately .5 miles south of Indn Route 4 from the intersection of Indn Route 4 and Indn Route 8030.
3. The third wastewater treatment plant is Kayenta, Arizona on the Navajo Nation (Navajo Tribal Reservation). Kayenta WWTP is approximately 2.50 miles southeast of AZ ST RD 163 and AZ ST RD 160.
4. The fourth wastewater treatment plant is Ganado, Arizona on the Navajo Nation (Navajo Tribal Reservation). Ganado WWTP is approximately 1.5 miles southwest of AZ ST RD 191 and AZ ST RD 264.
5. The fifth wastewater treatment plant is Tuba City, Arizona on the Navajo Nation (Navajo Tribal Reservation). Tuba City WWTP is approximately 4.75 miles southwest of AZ ST RD 160 and AZ ST RD 264.

2.0 RELATED WORK

A. General and Supplemental General Conditions of the Contract and Division 1

3.0 REFERENCES AND DEFINITIONS

A. The following definitions shall apply to the Work:

1. *Technical Specifications* shall refer to the Sections included under Divisions 1 through 48. The individual Technical Specifications may be referred to as "Supplemental Specifications," "Specification Sections," "Section," "STS," "Spec," or "Technical Specifications."
2. *Standard Specifications* shall refer to the Maricopa Association of Government (MAG) Uniform Standard Specifications for Public Works Construction – 2011 Edition. The individual Technical Specifications may be referred to as "Standard Specifications," "Specification Sections," "Section," "Std. Spec.," or "Technical Specifications."

3. A free copy of the standard specifications is available at
[HTTP://WWW.AZMAG.GOV/DOCUMENTS/2011_SPECIFICATIONS_BOOK.PDF](http://www.azmag.gov/documents/2011_specifications_book.pdf)

- B. Where all or part of a Federal, ASTM, ANSI, AWWA, Arizona Uniform Standard Specification for Public Works Construction etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.

4.0 PROJECT

- A. The work of this Contract generally consists of furnishing all labor, materials, equipment and incidentals required and performing all construction, installation and testing of all improvements, modifications and additions, all as shown on the drawings and specified in these Specifications.
- B. OWNER: NAVAJO TRIBAL UTILITY AUTHORITY (NTUA)
- C. ENGINEER: Smith Engineering Company
- D. Method of Payment: Bid Lots.
- E. The existing Chinle Waste Water Treatment Plant consists of the following:
 1. Headworks:
 - a. Raw Influent
 - i. Manhole Diversion
 - b. Headworks Channel
 - i. Manual Bar screen
 - ii. Horizontal Flow Grit Removal Channel
 - iii. Influent Flow Metering
 2. Lagoon #1
 - a. 2-25 HP Turbo Aerators
 - b. 1-25 HP Brush Aerator
 3. Lagoon #2
 - a. Stabilization Lagoon not in use
 - b. Contains dried sludge
 4. Lagoon #3
 - a. Not in use, may have water.
 5. Lagoon #4
 - a. Water
 - b. baffle
 6. Gas Chlorination Disinfection System with single train serpentine contact tanks and Chemical Storage Buildings
 7. Sulfur Dioxide De-chlorination System
 8. Effluent metering flume
 9. Effluent Nazlini Wash Discharge

10. Site Perimeter Fencing

F. The existing Pinon Waste Water Treatment Plant consists of the following:

1. Headworks:
 - a. Raw Influent Headworks Channel
 - i. Manual Bar screen
 - ii. Horizontal Flow Grit Removal Channel
 - iii. Influent Flow Metering
2. Lagoon #1
 - a. 1-25 HP splasher aerator
3. Lagoon # 2
 - a. Wind power mixers
4. Lagoon # 3
 - a. Wind power mixers
5. Lagoon # 4
 - a. Wetlands for effluent
6. Lagoon # 5
 - a. Not in use
7. Lagoon # 6
 - a. Not in use
8. Gas Chlorination Disinfection System with single train serpentine contact tanks and Chemical Storage Buildings
9. Sulfur Dioxide De-chlorination System
10. Effluent metering flume
11. Effluent discharge site
12. Site Perimeter Fencing

G. The existing Kayenta Waste Water Treatment Plant consists of the following:

1. Headworks:
 - a. Raw Influent Headworks Channel
 - i. Manual Bar screen
 - ii. Horizontal Flow Grit Removal Channel
 - iii. Influent Flow Metering

- b. Influent Lift Station
- 2. Lagoon #1
 - a. 7-2 HP aerators (only 2 functioning)
 - b. Baffle
- 3. Lagoon #2
- 4. Lagoon #3
- 5. Lagoon #4
 - a. Not in use
- 6. Lagoon # 5
 - a. Not in use
- 7. Lagoon # 6
- 8. Sand Filters
 - a. Not in use
- 9. Gas Chlorination Disinfection System with single train serpentine contact tanks and Chemical Storage Buildings
- 10. Sulfur Dioxide De-chlorination System
- 11. Effluent metering flume
- 12. Effluent Laguna Wash Discharge
- 13. Site Perimeter Fencing

H. The existing Ganaod Waste Water Treatment Plant consists of the following:

- 1. Headworks:
 - a. Raw Influent Headworks
 - i. Manual Bar screen
 - ii. Influent Lift Station
 - iii. Influent Flow Metering
- 2. Lagoon #1
 - a. 2-floating aerators
- 3. Gas Chlorination Disinfection System with single train serpentine contact tanks and Chemical Storage Buildings

4. Sulfur Dioxide De-chlorination System
5. Effluent metering flume
6. Effluent Pueblo Wash Discharge
7. Site Perimeter Fencing

I. Scope of Work

1. Furnish all labor, supervision, materials, equipment and incidentals required and construct the Wastewater Treatment Plant Upgrades, complete and ready for operation in its entirety as shown on the Drawings and as specified herein.
2. Work included in the bid lot includes the following, Chinle WWTP, Pinon WWTP, Kayenta WWTP, Ganado WWTP, and Tuba City WWTP:
 - a. All items specified in the contract documents unless otherwise specified herein to be included in an additive.
 - b. Allowances – see STS 01 21 00.
 - c. Clear and Grub of all areas affected by construction of this bid lot.
 - d. All construction staking, possible NPDES SWPPP permitting and BMPs that may be necessary, and all costs associated with completed the work in this bid lot.
 - e. Site Grading and Drainage
 - f. Yard Piping installation, modification, and testing of all sewer gravity, manholes, sewer forcemains, valving, and fittings necessary for full operation of the WWTP Process Systems listed in the Base Bid.
 - g. WWTP Process System includes all items necessary for installation, modification, and testing for full operation of the following unit processes.
 - i. Chinle WWTP
 - a) Earthwork and Sludge moving
 - b) Lagoon Construction
 - c) Yard Piping
 - d) Fencing and gates
 - e) 5-25-HP AIRE-O₂ Aerators (Install only)
 - f) 1-15-HP AIRE-O₂ Aerators (Install only)
 - g) Electrical Upgrades
 - h) Generators and structures
 - ii. Pinon WWTP
 - a) 7-15 HP AIRE-O₂ Aspirating Aerators (Install only)
 - b) 1-25 HP AIRE-O₂ Aspirating Aerators (Install only)
 - c) Fencing, gates and handrails
 - d) Electrical Upgrades
 - e) Generators and structures
 - iii. Kayenta WWTP

- a) Earthwork
- b) 3-10 HP AIRE-O₂ Aspirating Aerators (Install only)
- c) 3-15 HP AIRE-O₂ Aspirating Aerators (Install only)
- d) 2-25 HP AIRE-O₂ Aspirating Aerators (Install only)
- e) Electrical Upgrades
- f) Generators and structures

iv. Ganado WWTP

- a) 3-25 HP AIRE-O₂ Aspirating Aerators (Install only)
- b) Handrails
- c) Electrical Upgrades
- d) Generator and structures

v. Tuba City WWTP

- a) Yard Piping
- b) 9-25 HP AIRE-O₂ Aspirating Aerators (Install only)
- c) Electrical Upgrades

J. All materials, equipment, skills, tools and labor which are reasonably and properly inferable and necessary for the proper completion of the work in a substantial manner and in compliance with the requirements stated or implied by these Specifications or Drawings shall be furnished and installed by the CONTRACTOR without additional compensation, whether specifically indicated in the Contract Documents or not.

5.0 REGULATORY REQUIREMENTS

- A. Comply with all federal and local laws, regulations, codes and ordinances applicable to the Work, including stormwater pollution prevention requirements.
- B. References in the contract documents to local codes shall mean the latest edition of the appropriate code having jurisdiction including the following:
 - 1. International Building Code
 - 2. International Mechanical Code
 - 3. National Electrical Code
 - 4. International Plumbing Code
 - 5. International Existing Buildings Code
 - 6. International Energy Conservation Code
 - 7. International Fire Code
- C. Other standards and codes, which apply to the work, are designated in the specification.

D. Comply with environmental requirements listed below

1. Soils: Best management practices (BMPs) will be applied in order to curtail wind and water erosion of exposed soils during construction (see STS 01 57 23 – Temporary Pollution Control and STS 01 74 23 - Cleaning). To avoid soil pollution impacts during construction, any polluting materials generated will be dumped in the project area, but will be disposed of in accordance with appropriate guidelines.
2. Cultural Resources: Because the proposed action will not affect archaeological and cultural resources, traditional cultural properties, or visual aesthetics, no mitigation measures are needed. In the event that unexpected buried cultural resources are unearthed during the course of this project, work shall cease in that area and the Engineer, NTUA, the Supervisory Archaeologist with the Navajo Nation Historic Preservation Department and the State Archaeologist with the Arizona State Historic Preservation Office will be informed.
3. Water Quality: The EPA requires a NPDES Construction General Permit for all storm water discharges from construction permits that will result in the disturbance of one or more acres of total land. A Storm Water Pollution Prevention Plan must be prepared for the site and appropriate Best Management Practices must be implemented and maintained to the extent practicable, pollutants (primarily sediment, oil and grease, and construction material) in storm water runoff from entering the Waters of the United States. All new basins constructed with the proposed project or reviewed alternatives have been designed and the proposed project will be constructed with material that is waterproofed to minimize infiltration of wastewater into the groundwater.
4. Air Quality – (see STS 01 74 23) the following measures are recommended to reduce disturbance of particulate matter, including emissions caused by strong winds as well as machinery and trucks tracking soil off the construction site.
 - a. Suppress dust on traveled paths which are not paved through wetting, use of water trucks, chemical dust suppressants, or other reasonable precautions to prevent dust entering ambient air;
 - b. Cover trucks when hauling soil;
 - c. Minimize soil track-out by washing or cleaning truck wheels before leaving construction site;
 - d. Stabilize the surface of soil piles;
 - e. Create windbreaks.
 - i. Site restoration
 - ii. Remove un-used material;
 - iii. Remove soil piles via covered trucks.

6.0 OWNER OCCUPANCY

- A. The NAVAJO TRIBAL UTILITY AUTHORITY will occupy premises during performance of the Work for the operation and maintenance of the existing Wastewater Treatment Plants. Coordinate all construction operations to facilitate OWNER's usage.

7.0 CONTRACTOR'S USE OF PREMISES

- A. The CONTRACTOR shall coordinate use of the premises, for storage and the operations of the CONTRACTOR's workforce, with the OWNER to minimize conflict and to facilitate OWNER usage.
- B. The CONTRACTOR shall maintain access and utilities to the existing treatment facilities at all times.
- C. CONTRACTOR staging/laydown areas shall be as identified on the Drawings. Obtain written permission from OWNER if additional storage or work areas are needed to perform the work.
- D. The CONTRACTOR shall provide spill containment for all regulated materials and NFPA rated containment for all flammable materials.
- E. CONTRACTOR shall assume full responsibility for security of all his own and his sub-CONTRACTORS, materials and equipment stored on the site.
- F. If directed by the OWNER, the CONTRACTOR shall move any stored items which interfere with operations of OWNER or other CONTRACTORS.
- G. Additional CONTRACTORS may be onsite during construction of this project; CONTRACTOR shall coordinate with each other as needed.
- H. The CONTRACTOR will have access to the site to conduct pre-construction potholing and dewatering investigations if needed. CONTRACTOR is required to coordinate with OWNER prior to accessing the site.
- I. CONTRACTOR shall continue to be allowed access to all facilities constructed to perform testing and adjustments as needed until final completion is issued.
- J. CONTRACTOR shall be fully responsible for the work of all subcontractors.

PART 2: PRODUCTS - NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION

SUPPLEMENTAL SECTION 01 21 00

ALLOWANCES

PART 1: GENERAL

1.0 SUMMARY

- A. Schedule of monetary amounts of allowances in Contract Sum for purchase and installation of designated products.
- B. Costs in Contract Price other than in Allowances.
- C. Procedure for administration of Allowances.

2.0 RELATED WORK

- A. General and Supplemental General Conditions of the Contract and Division 1.

3.0 ADJUSTMENT OF ALLOWANCES

- A. Contractor shall include in Contract Price all allowances named in Contract Documents and shall cause Work so covered to be done by such Subcontractors, manufacturers, fabricators, suppliers, or distributors and for such sums within limit of allowances as may be acceptable to Owner.
- B. Contactor agrees that original Contract Price includes all costs and profit on account of cash allowances. No demand for additional cost or profit in connection therewith will be valid.
- C. Allowances included in the bid tabulation are estimated dollar amounts. The actual dollar amounts reimbursed may be less than, equal to, or greater than the stated allowances. The Owner shall reimburse the Contractor the actual amount based on invoices received by the provided. The Contractor shall, at his expense, furnish necessary equipment, tools, and labor in the performance of the work involved in the allowances.
 - 1. The Contractor shall not proceed with work that exceeds the amount of the allowance without an approved Change Order that adjusts the contract price, accordingly.
 - 2. Any unused balance of the allowances shall revert to the Owner upon completion of the project. Prior to final payment, the original amount provided for the allowances shall be adjusted to actual costs by deductive Change Order, adjusting the contract price, accordingly.

4.0 SCHEDULE OF ALLOWANCES

- A. See the Bid Schedule for costs allotted for each allowance.
- B. Testing Allowance – See STS 01 21 19, Testing and Quality Assurance.

- C. Construction Power Allowance – For fees and costs billed to CONTRACTOR from NTUA ELECTRIC associated with installing and removing temporary construction power. The CONTRACTOR is responsible for all other costs associated with providing Construction Power outside the NTUA ELECTRICS fees including but not limited to power usage costs.

5.0 CONTRACTOR COSTS INCLUDED IN ALLOWANCE

- A. Cost of product or service to Contractor or Subcontractor
- B. The Contractor shall make no claim, nor receive any compensation, for anticipated profits, loss of profit, damages, or any extra payment due to any unexpended portion of the allowances.
- C. The Contractor is to include time for allowance work in the construction schedule. No adjustment of Contract Time shall be allowed for any work performed under allowance items.
- D. Allowance items shall be included in the Schedule of Values.
- E. Unless otherwise indicated in the specific measurement and payment provisions under allowance items, the measureable and allowable costs for work performed under an Allowance item shall be limited to the actual, demonstrable, and direct costs associated with that Allowance item. Shipping and sales taxes are allowable costs.

6.0 CONTRACTOR COSTS INCLUDED IN CONTRACT PRICE BUT NOT INCLUDED IN ALLOWANCES

- A. See ARTICLE 11 of the General Conditions of the Contract – COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK.
- D. For costs associated with testing, see STS 01 21 19.
- B. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment on account of any of the foregoing will be valid.
- C. Protection of products from elements and from damage.

7.0 ENGINEER RESPONSIBILITIES

- A. Consult with Contractor in consideration of products and suppliers.
- B. Select products, obtain Owner's written decision, and transmit full information to Contractor, including:
 - 1. Manufacturer, subcontractor, product, model or catalog number, accessories, attachments, and finishes.
 - 2. Supplier as applicable.

3. Cost to Contractor, delivered to Site and installed.

8.0 CONTRACTOR RESPONSIBILITIES

- A. Assist Engineer in determining suppliers; obtain proposals when requested.
- B. Make recommendations for Engineer's consideration.
- C. Promptly notify Engineer of any reasonable objections against supplier.
- D. On notification of selection execute purchase agreement with designated supplier.
- E. Arrange for and process Shop Drawings, product data, and samples
- F. Arrange for delivery of new products. Promptly inspect products upon delivery for completeness, damage, and defects. Submit claims for transportation damage.
- G. Arrange for pickup, transportation, refurbishment and delivery of Owner furnished equipment to be refurbished prior to reinstallation.
- H. Provide warranties for products and installation.

9.0 PAYMENT PROCEDURE

- A. See STS 01 29 76.

10.0 CORRELATION WITH CONTRACTOR SUBMITTALS

- A. General: Submit listed submittals in accordance with conditions of the Contract and with Specification 01 33 00.
- B. Product Data: Submit product data, including manufacturer's specifications, installation instructions, and general recommendations for installation. Also include manufacturer's certification or other data substantiating that products comply with requirements of Contract Documents. Clearly identify product/model to be used.
- C. Test Reports: Submit for acceptance, complete test reports from approved independent testing laboratories certifying that product conforms to performance characteristics and testing requirements specified.
- D. Shop drawings: Submit clear, concise drawing showing model number, size, arrangement and configuration of all products specified. Minimum sheet size is 8.5" X 11".

PART 2 PRODUCTS (NOT USED) & PART 3 EXECUTION (NOT USED)

END OF SECTION

SUPPLEMENTAL SECTION 01 21 19

TESTING AND QUALITY ASSURANCE

PART 1: GENERAL

1.0 SUMMARY

- A. This Section includes testing and quality control measures required on this project. The Section is additional to requirements specified for materials and work in the standard specifications and other supplemental specifications.
- B. Materials and equipment are subject to inspection, sampling, and testing before acceptance of the work.

2.0 RELATED WORK

- A. General and Supplemental General Conditions of the Contract and Division 1

3.0 REFERENCES AND DEFINITIONS

- A. The CONTRACTOR shall:
 - 1. Conform work to reference standards by date of issue current on date of Contract Documents. Dates specified in individual Sections supersede all other dates of issue
 - 2. Request clarification from ENGINEER before proceeding should specified reference standards conflict with Contract Documents, The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.
- B. Where all or part of a Federal, ASTM, ANSI, AWWA, and Arizona Uniform Standard Specification for Public Works Construction etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.

4.0 SUBMITTALS

- A. General: Submit listed submittals in accordance with conditions of the Contract and with Specification 01 33 00.
- B. Test Reports from tests performed by independent testing firm: Submit for acceptance, complete test reports from approved independent testing laboratories certifying that product conforms to performance characteristics and testing requirements specified herein and in other supplemental/standard specifications. Independent firm to submit reports to the ENGINEER and CONTRACTOR, in duplicate, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.

- C. Test Reports from tests performed by CONTRACTOR: Submit for acceptance, complete test reports from CONTRACTOR certifying that product conforms to performance characteristics and testing requirements specified herein and in other supplemental/standard specifications.

5.0 QUALITY ASSURANCE

A. Quality Assurance/Control of Installation – The CONTRACTOR shall:

- 1. Comply fully with manufacturers’ instructions, including each step in sequence.
- 2. Request clarifications from ENGINEER before proceeding should manufacturers’ instructions conflict with Contract Documents.
- 3. Request clarification from ENGINEER before proceeding should specified reference standards conflict with Contract Documents. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.
- 4. Comply with specified standards as a minimum quality for the work except when more stringent specified tolerances, codes, or requirements indicate higher standards or more precise workmanship are required.
- 5. Make sure work is performed by qualified persons.
- 6. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.

B. Testing Laboratory Services

- 1. Testing may be provided by the ENGINEER, if the ENGINEER is independent of the CONTRACTOR, except on a design-build project.
- 2. Reports will be submitted by the independent firm to the ENGINEER and CONTRACTOR, in duplicate, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.

C. All other appurtenances/equipment (see individual specification)

- 1. Operation..... CONTRACTOR
- 2. Witness..... OWNER & ENGINEER
- 3. Payment (or cost)..... CONTRACTOR

D. Electrical System Operation

- 1. Operation..... CONTRACTOR

2. Witness..... OWNER & ENGINEER

3. Payment (or cost)..... CONTRACTOR

E. Control Systems Operation

1. Operation..... CONTRACTOR

2. Witness..... OWNER & ENGINEER

3. Payment (or cost)..... CONTRACTOR

F. Manufacturer’s Field Services and Reports – See STS 01 73 19 for additional requirements.

G. Special Inspections: Pursuant to section 1704 of the International Building Code, special inspection is required for the following items:

1. Concrete and reinforcements

2. Structural Welding: Field welding and welding not done in an approved fabricators shop.

3. Anchor bolts

6.0 TESTING METHODS

A. All materials and equipment shall be tested pursuant to their technical specification (unless otherwise specified herein) and the manufacturer’s recommendations by the CONTRACTOR. The CONTRACTOR shall submit all test results to the ENGINEER prior to acceptance of the project.

B. Soil Compaction tests shall be taken in accordance with ASTM D2922 and D3017. Method ASTM D2922 must be verified with ASTM D1556 for in-place density test with the sand cone method as follows: Sand Cone Test ASTM D1556 per 10 nuclear density test ASTM D2922.

C. See STS 31 20 00 for testing requirements for Paved and Building Slab Areas and Foundation Wall Backfills.

D. See STS 31 20 00 for testing requirements for Engineered Fill.

E. Concrete testing shall be per Section 03 30 00.

PART 2: PRODUCTS

This section not used.

PART 3: EXECUTION

1.0 FIELD QUALITY CONTROL

A. Testing Laboratory Services

1. The OWNER will appoint and CONTRACTOR will employ and pay for services of a firm independent of the CONTRACTOR to perform testing.
2. The independent firm will perform tests and other services specified in individual Specification Sections and as required by the OWNER.
3. CONTRACTOR shall:
 - a) Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage and assistance as requested.
 - b) Notify ENGINEER and independent firm 8 hours prior to expected time for operations requiring services.
 - c) Make arrangements with independent firm and pay for additional samples and tests required for CONTRACTOR'S use.

B. A partial list of field tests required on this project, parties responsible for conducting the tests, and parties responsible for payment of the tests is presented below. Where tests specified in other sections of these specifications are not listed below, the CONTRACTOR will request additional testing information from the OWNER.

1. Compaction tests (subgrade, ABC, engineered fill, pipe bedding, backfill, etc.):
 - a) Compaction test:..... Independent Testing Laboratory
 - b) Payment:..... CONTRACTOR
2. Concrete tests:
 - a) Slump test:..... Independent Testing Laboratory
 - b) Air test..... Independent Testing Laboratory
 - c) Unit weight test Independent Testing Laboratory
 - d) Prepare test cylinders Independent Testing Laboratory
 - e) Protect test cylinders CONTRACTOR
 - f) Perform cylinder test: Independent Testing Laboratory
 - g) Payment:..... CONTRACTOR
3. Waterline:
 - a) Pressure and bacteria test: CONTRACTOR
 - b) Witness: ENGINEER
 - c) Payment (or cost): CONTRACTOR
4. Sewer line (Gravity):
 - a) Leak, exfiltration and air testing: CONTRACTOR
 - b) Witness:ENGINEER
 - c) Payment (or cost):CONTRACTOR
5. Sewer line (Pressure):

- 1) Pressure:..... CONTRACTOR
- 2) Witness:..... ENGINEER
- 3) Payment (or cost): CONTRACTOR

6. Hydraulic structures testing:

- 1) Hydraulic structure test:.....CONTRACTOR
- 2) Witness:..... ENGINEER
- 3) Payment (or cost): CONTRACTOR

7. All other appurtenances/equipment (see individual specification)

- a) Operation..... CONTRACTOR
- b) Witness OWNER & ENGINEER
- c) Payment (or cost)..... CONTRACTOR

8. Electrical System Operation – SEE ELECTRICAL SPECIFICATIONS

9. Control Systems Operation – SEE CONTROL SYSTEM SPECIFICATIONS

C. Retesting required because of non-conformance to specified requirements shall be performed by the same independent firm on instructions by the ENGINEER.

D. Tolerances – CONTRACTOR shall:

- 1. Monitor tolerance control of installed products to produce acceptable work. Do not permit tolerances to accumulate.
- 2. Comply with manufacturers’ tolerances. Should manufacturer’s tolerances conflict with Contract Documents, request clarification from ENGINEER before proceeding.
- 3. Adjust Products to appropriate dimensions; position before securing Products in place.

E. TESTING FREQUENCY

- 1. EMBANKMENT AND STRUCTURAL FILL for water holding basins, paved and building slabs and foundation wall backfills: see STS 31 20 00.
- 2. STRUCTURAL CONCRETE SUBGRADE (MANHOLES, JUNCTION BOXES, INLETS, SLOPE-BLANKETS, ETC.): See STS 31 20 00 for earthwork testing requirements. Sub-grade testing may be consecutive with concrete cylinder tests.
- 3. CONCRETE: Testing shall be taken for each concrete structure or every third truck on pours for structures over 30 cubic yards. On structures less than 30 cubic yards, the concrete shall be tested once. The testing reports shall identify the structure for which the pour was used. CONTRACTOR is responsible for tracking truck invoices to structures poured. Non complying slump tests will require rejection of concrete. Non-complying cylinder tests shall require the CONTRACTOR to core the non-compliant structure for testing. Remediation of non-compliant structures is the responsibility of the CONTRACTOR.

2.0 MEASUREMENT AND PAYMENT

Testing allowances are provided as part of the project.

- A. Costs included in Testing Allowances: Cost of engaging an independent testing firm, execution of tests by the testing firm, and reporting results by the testing firm.
- B. Costs Not Included in the Testing Allowance, but included in the Contract Sum/Price:
 - 1. Costs of incidental labor and facilities required to assist testing firm.
 - 2. Costs of testing laboratory services used by CONTRACTOR separate from Contract Document requirements.
 - 3. Costs of retesting upon failure of previous tests as determined by ENGINEER, except that retesting for that lot does not exceed 10 percent of the testing for successful tests, may be included in the Testing Allowance.
 - 4. Costs of testing performed by the CONTRACTOR (i.e. pressure test on waterline)
- C. Payment Procedure – The CONTRACTOR shall:
 - 1. Submit two copies of the testing firm’s invoice to OWNER.
 - 2. Receive reimbursement for actual invoice of testing firm upon certification that payment has been made, at next application for payment from OWNER.
- D. Differences in cost will be adjusted by Change Order.

END OF SECTION

SUPPLEMENTAL SECTION 01 29 76

APPLICATION FOR PAYMENT

PART 1: GENERAL

1.0 SUMMARY

- A. This Section specifies administrative and procedural requirements governing the following:
 - 1. Schedule of Values
 - 2. Application for Payment

2.0 RELATED WORK

- A. General and Supplemental General Conditions of the Contract and Division 1

3.0 SCHEDULE OF VALUES

- A. Format the Schedule of Values per EJCDC C-620(07) Application for Payment (Progress Estimate Unit Price Work) from; see Construction Forms.
- B. If the project is a unit price/bid project, the bid schedule will be used as the Schedule of Values.
- C. Provide a separate line item for each Change Order to the Contract.

4.0 APPLICATIONS FOR PAYMENT

- A. Submit Applications for Payment on a monthly basis.
- B. Submit a completed *PARTIAL PAYMENT SCHEDULE* form with each Application for Payment; see *Partial Payment Form* in the Construction Forms Section.
- C. Submit a *MATERIAL-ON-HAND SUMMARY SHEET* with each Application of Payment; see *Stored Materials Summary* in the Construction Forms Section.
- D. Submit an updated *SCHEDULE OF VALUES FORM* with the Application for Payment; see *Schedule of Values Form* in the Construction Forms Section.
- E. Transmit an executed copy of each Application to the ENGINEER which shall be complete, including all waivers of lien and other attachments required by the Contract Documents.
- F. Transmit each copy with a transmittal form listing attachments, and recording appropriate information related to the application in a manner acceptable to the ENGINEER.
- G. Submit waivers of lien from subcontractors for the period of construction covered by the current application.

- H. Submit certification that Record Drawing mark-ups are updated through the current pay period per the requirements of Specification 01 78 39 Project Record Documents.

5.0 APPLICATION FOR PAYMENT AT TIME OF SUBSTANTIAL COMPLETION

- A. In addition to the requirements of paragraph three, submit the following with the Application for Payment at the time of Substantial Completion:
 - 1. Executed Substantial Completion Certificate
 - 2. Punch list of incomplete items
- B. For Substantial Completion, the following Work at a minimum shall be completed, field pre-operational and startup tested and fully operational by the Substantial Completion date, subject to the ENGINEER'S approval
 - 1. All structures/treatment process work.
 - 2. All necessary electrical, mechanical, plumbing, HVAC, instrumentation, interior finish, etc. for proper operation of all treatment processes and Owner occupancy of all structures.
 - 3. All site work including final grading.
 - 4. All Training, and Operations and Maintenance Manuals.
 - 5. All other work in the contract unless otherwise specifically identified in Section 6.0 herein.
- C. The CONTRACTOR is encouraged to submit all other Project Record Documents (STS 01 78 39) and undertake Contract Closeout during Substantial Completion.

6.0 FINAL APPLICATION FOR PAYMENT

- A. If, on the basis of ENGINEER'S observation of the work during construction and final inspection, and ENGINEER'S review of the final Application for Payment and accompanying documentation as required by the Contract Documents, ENGINEER is satisfied that the Work has been completed and CONTRACTOR'S other obligations under the Contract Documents have been fulfilled, ENGINEER will, within ten days after receipt of the final Application for Payment, indicate in writing ENGINEER'S recommendation of payment and present the Application for Payment to OWNER for payment. At the same time ENGINEER will also give written notice to OWNER and CONTRACTOR that the Work is acceptable. Otherwise, ENGINEER will return the Application for Payment to CONTRACTOR, indicating in writing the reasons for refusing to recommend final payment, in which case CONTRACTOR shall make the necessary corrections and resubmit the Application for Payment.
- B. In addition to the requirements of Section 4.0 herein and the items listed in the General Conditions of the Contract and the Supplemental Conditions of the contract, submit the following with the Final

Application for Payment.

1. Certificate of Substantial Completion
2. Affidavit of Payment and Release of Liens
3. Certification of Project Acceptance and Performance
4. Consent of Surety to Final Payment
5. Record Drawings and Record Specifications as required by Specification 01 78 39.
6. Record Drawings and O&M Manuals Acceptance including, if applicable, Mechanical Controls Diagrams, Operation and Maintenance Training Videos, and Approved Fire Protection Shop Drawings as required by Specification 01 77 23. Certificate of Substantial Completion

PART 2: PRODUCTS

This section not used.

PART 3: EXECUTION

This section not used.

END OF SECTION

SUPPLEMENTAL SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1: GENERAL

1.0 SUMMARY

A. Section includes procedures for preparing and transmitting submittals required by specification sections for a product, material, or construction method:

1. Shop drawings.
2. Product data.
3. Manufacturer's certificates.
4. Design data and calculations.
5. Manufacturer's instructions.
6. Manufacturer's field service reports.
7. Samples.
8. Operation and maintenance manuals (timing, quantity, content and form).
9. Field Testing

B. It is the responsibility of the GENERAL CONTRACTOR to convey the requirements of this Section to their SUB-CONTRACTORS and their suppliers and vendors.

2.0 RELATED WORK

A. General and Supplemental General Conditions of the Contract and Division 1

3.0 SUBMITTALS

A. Schedule submittals to expedite Work. Unless otherwise indicated in this Section, submittals shall be submitted within 30 days of date of Notice to Proceed.

B. Preparation:

1. Provide separate submittal for each specification section requiring submittals. Where multiple sections relate to the same system or element and are being provided from the same source, a single combined submittal is acceptable.

2. Coordinate submission of related items. Group submittals of related products in a single transmission.
3. Include all submittal material requested for that Section.
4. Identify variations from requirements of Contract Documents. State product and system limitations which may adversely affect Work.
5. Mark or show dimensions and values in same units as specified.

C. CONTRACTOR responsibilities:

1. Review submittals prior to transmittal. Verify compatibility with field conditions and dimensions, product selections and designations, quantities, and conformance of submittal with requirements of Contract Documents. Return non-conforming submittals to preparer for revision rather than submitting for review.
2. Coordinate submittals to avoid conflicts between various items of work.
3. Submittal transmittal form:
 - a) Include with each submittal a transmittal form. Sample copy of an acceptable form is at Attachment A. CONTRACTOR's standard submittal form may be used provided it contains essentially the same information as sample.
 - b) Identify Project, CONTRACTOR, SUBCONTRACTOR, supplier, manufacturer, pertinent drawing sheet and detail numbers, and associated Specification Section numbers.
 - c) Sequentially number transmittal forms. Re-submittals shall have original number with a suffix. Acceptable form of number is SSSS(S)-NN-T where:
 - i. SSSS(S) indicates 5 OR 6 digit specification section number.
 - ii. NN indicates different submittals for that specification section.
 - iii. T indicates the number of times that submittal has been made.
4. Failure of CONTRACTOR to review submittals prior to transmittal for review shall be cause for rejection.
5. Contract will list where submitted equipment, product or material deviates from specification.
6. Incomplete, improperly packaged, unreadable due to small and/or blurry print, and submittals from sources other than CONTRACTOR will not be accepted.

D. Transmittal: Where possible, transmit all submittals electronically. Where electronic submittal is not possible, submit seven (7) paper copies for A/E retention plus as many copies as CONTRACTOR desires returned after review. Exception: Retained quantities for samples, color charts, and manufacturer's equipment manuals shall be as specified elsewhere herein.

- E. Review: A/E will review and return submittals with comments.
- F. Do not fabricate products or begin work which requires submittals until return of reviewed submittal with A/E acceptance.
- G. On return, promptly distribute reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.
- H. Resubmission:
 - 1. Revise and resubmit submittals as required within 15 days of return from initial review.
 - 2. Make re-submittals under procedures specified for initial submittals.
 - 3. Identify all changes made since previous submittal.

4.0 QUALITY ASSURANCE

- A. Where required by Specification Sections, provide quality assurance submittals:
 - 1. Qualification data: Written information demonstrating capabilities and experience of firm or person. Include lists of complete projects with names and contact information for references.
 - 2. Manufacturer's certificates: Submit reference data, affidavits, and certifications on manufacturer's letterhead certifying that products conform to or exceed specified requirements. Certificates may be based on recent or previous test results supplied by manufacturer and accepted by A/E.
 - 3. Installer approval: Certification on manufacturer's letterhead that installer complies with requirements and is approved for installing manufacturer's products.
 - 4. Welding certificates: Written certification that welding procedures and personnel comply with requirements. Submit record of Welding Procedure Specifications (WPS) and Procedure Qualification Record (PQR) on American Welding Society (AWS) forms. Include names of firms and personnel certified.
 - 5. Field test reports: Written reports from qualified testing agency indicating and interpreting results of field tests performed either during or after installation for compliance with specified requirements. The CONTRACTOR shall perform field testing as required by specifications.

5.0 SUBMITTAL REVIEW

- A. A/E will review submittals for sole purpose of verifying general conformance with design intent and general compliance with Contract Documents. Approval of submittal by A/E does not relieve CONTRACTOR of responsibility for correcting errors which may exist in submittal or from meeting

requirements of Contract Documents.

- B. Review time: Initial review will be performed within 14 days of receipt. Reviewer reserves right to withhold action on a submittal requiring review of related submittals until related submittal is received. Additional time will be required if processing must be delayed to permit review of related subsequent submittals. A/E will review re-submittals within 14 days.
- C. Review actions: After review, A/E will return submittals marked as follows to indicate action taken:

This submittal has been reviewed for compliance with general requirements of design and arrangement only and is not a contract document. Acknowledgement of compliance does not relieve Contractor of responsibility for performance of the work in compliance with all provisions and requirements of the contract documents. Job measurements and coordination of all dimensions for proper fit of all parts of the work and performance of all equipment supplied to meet specification requirements are and remain specific responsibilities of the Contractor.	
<input type="checkbox"/> Compliance acknowledged subject to the foregoing: Distribute	<input type="checkbox"/> Compliance acknowledged as noted and subject to the foregoing: Distribute
<input type="checkbox"/> Compliance acknowledged as noted and subject to the foregoing: Revise and Resubmit for record: Distribute	<input type="checkbox"/> Rejected – Revise and resubmit for review

6.0 DRAWINGS

- A. Where required by specifications or otherwise needed, prepare drawings illustrating portion of Work for use in fabricating, interfacing with other work, and installing products. Contract Drawings shall not be reproduced and submitted as shop drawings.
- B. When construction is complete, prepare and submit red-lined copies of the Contract Drawings showing clearly how construction deviated from the design, along with the authority for the deviation or change.
- C. Electronic Format:
 - 1. Size printable to: 8-1/2 by 11 inches minimum and 24 by 36 inches maximum.
 - 2. Present in a clear and thorough manner. Title each drawing with Project name. Identify each element of drawing with reference number.
 - 3. Plans, elevations, sections, and detail shop drawings shall be to scale with scale indicated.
 - 4. Indicate field verified dimensions. Show relationship of products to adjacent work. Note coordination requirements.

5. Schematics and diagrams shall be logically arranged and presented in a clear understandable manner with all items labeled.
6. Internal wiring diagrams: Provide internal wiring and elementary ladder diagrams for factory pre-wired equipment.
7. Control diagrams: Show relative positions of each component as a system diagram.

7.0 PRODUCT DATA

- A. Provide product data such as manufacturer's brochures, catalog pages, illustrations, diagrams, tables, performance charts, and other material which describe appearance, size, attributes, code and standard compliance, ratings, and other product characteristics.
- B. Form:
 1. Provide all critical information such as reference standards, performance characteristics, capacities, power requirements, wiring and piping diagrams, controls, component parts, finishes, dimensions, and required clearances.
 2. Submit only data which are pertinent. Mark each copy of manufacturer's standard printed data to identify products, models, options, and other data pertinent to project.
 3. Modify manufacturer's standard schematic drawings and diagrams and supplement standard data to provide specific information applicable to project. Delete information not applicable.
 4. Colors and patterns: Unless color and pattern is specified for product, submit accurate color and pattern charts or samples illustrating manufacturer's full range for selection by OWNER. Submit two (2) hard copies only.
 5. Provide all passwords and instructions for control panels and PLCs with initial submittal.

8.0 DESIGN DATA AND CALCULATIONS

- A. Where required by specification sections, provide basic calculations, analyses, and data to support design decisions and demonstrate compliance with specified requirements. State assumptions and define parameters. Give general formulas and references. Provide sketches as required to illustrate design method and application.
- B. Arrange calculations and data in a logical manner with suitable text to explain procedures and order.
- C. Indicate name, title, and telephone number of individual performing design and include professional seal of designer where applicable or required.

9.0 MANUFACTURER'S INSTRUCTIONS

- A. Where required by specification sections, provide manufacturer's instructions for activities such as delivery, storage, assembly, installation, wiring, start-up, adjusting, and finishing.
- B. Indicate pertinent portions and identify conflicts between manufacturer's instructions and Contract Documents.
- C. Where appropriate, include preparation procedures, service connection requirements, critical ambient conditions, foundation requirements, special precautions, adjustment requirements, alignment procedures, leveling, purging, charging, lubrication and cleaning prior to operation and/or OWNER'S acceptance.
- D. Installation (e.g., assembly, mounting, or wiring) and start-up instructions shall be submitted and available for review in the field prior to scheduled material or equipment installation.

10.0 SAMPLES

- A. Submit samples to illustrate functional and aesthetic characteristics of products with all integral parts and attachment devices. Include full range of manufacturer's standard finishes, indicating colors, textures, and patterns for A/E selection.
- B. Submission: Submit the number of samples specified in individual specification sections. One sample will be retained by A/E.
- C. Label with identification related to submittal transmittal form.

11.0 MANUFACTURER'S FIELD SERVICE REPORTS

- A. When an individual specification section requires services of manufacturer's field representative, submit report of observations, site decisions, and instructions given to installers.
- B. Form:
 - 1. Present complete information in clear concise manner.
 - 2. Bind with titled cover in folder or binder.
- C. Report shall include:
 - 1. Time, location, conditions, and duration of activity.
 - 2. Names of persons performing and witnessing activity.
 - 3. Equipment used.
 - 4. Description of activity, data recorded, and results.
 - 5. Deficiencies found, corrective measures, and results of retesting.

6. Other pertinent data.

D. Submit report within 30 days of construction site service visit.

12.0 OPERATION AND MAINTENANCE DATA

A. See Section 01 77 23.

13.0 WARRANTIES AND BONDS

A. See paragraph 6.19, regarding the "CONTRACTOR's General Warranty and Guarantee" of the Standard Conditions of the Contract.

B. Submittals

1. Submit written warranties to the ENGINEER prior to Substantial Completion. If the Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the ENGINEER.
2. When a special warranty is required to be executed by the CONTRACTOR, a SUBCONTRACTOR, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the ENGINEER for approval prior to final execution.
3. Refer to individual Sections for specific content requirements, and particular requirements for submittal of special warranties.
4. With the final application for payment, the CONTRACTOR shall compile copies of each required warranty and bond properly executed by the SUBCONTRACTOR, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of these Specifications.
5. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents and sized to receive 8-1/2-in by 11-in paper.
 - a) Table of Contents: Typed, in the sequence of the Table of Contents of these Specifications, with each item identified with the number and title of the Section in which specified and the name of the product or work item.
 - b) Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of the installer, supplier, and manufacturer.
 - c) Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS", the project title. On the front cover provide a listing of the name, address, and telephone number of the equipment supplier(s).

- d) When operation and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

C. Equipment

1. All equipment shall be warranted for a minimum period of one (1) year by the manufacturer and the CONTRACTOR. The warranty period shall commence upon Substantial Completion. Refer to individual Sections of Divisions 2 through 46 for warranties required for a period beyond the one (1) year minimum, and for additional requirements and particular requirements of special warranties.
2. The equipment shall be warranted to be free from defects in workmanship, design, and materials. If any part of the equipment should fail during the warranty period, it shall be replaced at no expense to the OWNER.
3. The manufacturer's warranty period shall run concurrently with the CONTRACTOR's warranty period.
4. The replacement or repair (including the cost of parts and labor) of those items normally consumed in service, such as pump packing, oil, grease, and the like, shall be considered as part of routine preventive

D. Additional Requirements

1. See article 13 of the Standard Conditions of the Contract regarding TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK.
2. Related Damages and Losses: When correcting warranted work that has failed, remove and replace other work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted work, at no cost to the OWNER.
3. Reinstatement of Warranty: When work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
4. Replacement Cost: Upon determination that work covered by a warranty has failed, replace or rebuild the work to an acceptable condition complying with requirements of Contract Documents. The CONTRACTOR is responsible for the cost of replacing or rebuilding defective work regardless of whether the OWNER has benefited from use of the work through a portion of its anticipated useful service life. The replacement work shall be warranted as new.
5. OWNER's Recourse: Written warranties made to the OWNER are in addition to implied warranties, and shall not limit the duties, obligations, rights, and remedies otherwise

available under the law, nor shall warranty periods be interpreted as limitations on time in which the OWNER can enforce such other duties, obligations, rights, or remedies.

6. Rejection of Warranties: The OWNER reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
 7. The OWNER reserves the right to refuse work for the project where a special warranty, certification, or similar commitment is required on such work or part of the work, until evidence is presented that entities required to countersign such commitments are willing to do so.
- E. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the CONTRACTOR of the warranty on the work that incorporates the products, nor does it relieve suppliers, manufacturers, and sub-contractors required to countersign special warranties with the CONTRACTOR.

14. SUBSTITUTIONS

- A. A request for a substitution constitutes a representation that the Contractor:
1. Has investigated the proposed product and determined that it is equal to or superior in all respects to that specified.
 2. Will provide the same warranties or bonds for the substitution as for the product specified.
 3. Will coordinate the installation of an accepted substitution into the Work, and make such other changes as may be required to make the Work complete in all respects.
 4. Waives all claims for additional costs, under his responsibility, which may subsequently become apparent.
- B. Contractor shall make written application to ENGINEER for review of a proposed substitute item of material or equipment that Contractor seeks to furnish or use.
- C. The application:
1. certify that the proposed substitute item will:
 - a) perform adequately the functions and achieve the results called for by the general design,
 - b) be similar in substance to that specified, and
 - c) be suited to the same use as that specified;
 2. will state:
 - a) the extent, if any, to which the use of the proposed substitute item will prejudice Contractor's achievement of Substantial Completion on time;

- b) whether or not use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item; and
 - c) whether or not incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty;
 - 3. will identify:
 - a) Not used.
 - b) For all others, see paragraph E (Qualification packages for substitution listing) of this section for details.
 - 4. and shall contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including costs of redesign and claims of other contractors affected by any resulting change,
- D. QUALIFICATION PACKAGES FOR SUBSTITUTION LISTINGS: The qualification package for the substitution of equipment items or products the CONTRACTOR proposes to furnish shall include but not be limited to, the following information appropriate for the particular item:
 - 1. Manufacture's Experience: The manufacturers shall certify that their experience includes a minimum of ten installations where identical equipment has been in operation successfully in a similar process.
 - 2. Equipment Requirements: A complete set of drawings, specifications catalogue, cut-sheets and detailed descriptive material of proposed major equipment items or products. This information shall identify all technical and performance requirements stipulated in the specifications.
 - 3. Equipment Details: Detailed information shall be submitted for all items.
 - 4. Materials of Construction: List showing materials of construction of all components.
 - 5. Recommended Spare Parts: List of original manufacturer's spare parts, manufacturer's current prices and recommended quantities to be maintained in storage for a minimum of one year.
 - 6. MAINTENANCE MATERIALS: Provide:
 - a) Lubricant for all equipment and facilities sufficient for three months' normal usage.
 - b) Any non-standard tools required adjusting or service equipment supplied.
 - 7. Erection Requirements: Information on equipment field erection requirements.

8. Maintenance Requirements: A maintenance schedule showing the required maintenance, frequency of maintenance, lubricants and other items required at each regular preventative maintenance period.
9. Electrical Requirements: Process equipment electrical requirements and schematic diagrams.
10. List of Deviations; Detailed written documentation with discussion of all deviations of equipment from the contract documents.
11. O& M Manual: One representative O & M Manual.
12. Installation List: Complete Past Experience Installation List complete with plant location, design flow and loadings, plant design discharge quality, design engineer, firm, owners, manager, operator, superintendent, and telephone number for each. Identify which plants on the installation list meet the experience requirements of the Specification.
13. Guarantee: Copy of the supplier's guarantee of the treatment process and equipment for one year starting after successful completion of start-up.
14. INSTALLATION OF WASTEWATER TREATMENT FACILITY EQUIPMENT - The applicant shall agree to adhere to the work specified to be completed by the manufacturer in the STS 01 73 19. The installation work shall be included in the capital cost of the equipment.
15. PROCESS FLOW DIAGRAM AND EQUIPMENT DESCRIPTION: The application package shall provide a process flow diagram and a detailed materials and equipment list of all equipment for the treatment system. Piping and Instrumentation Diagrams shall be submitted.
16. SYSTEM LAYOUT DRAWINGS AND CALCULATIONS:
 - a) The application package shall provide drawings showing the proposed locations for all major equipment. The existing WWTS, buildings and locations for the new treatment systems are shown in the Engineer's Drawings.
 - b) The application package shall provide drawings showing modifications to the structure or enclosure that treatment system is to be installed in.
 - c) The application package shall provide drawings showing modifications to the electrical system for a fully operating treatment system.
 - d) The application package shall provide documentation showing modifications to the SCADA system for a fully operating treatment system.
 - e) The application package shall provide drawings showing modifications to the yard and process piping required for a fully operating treatment system.

- f) The application shall provide all design calculations for the treatment system showing that the system complies with the treatment requirements specified in that system's specification.
- g) A set of hydraulic calculations shall also be submitted showing the system conforms to the hydraulic requirements in the Engineer's Drawings.
- h) All calculations shall be completed for the current and future design flow rates identified in that system's technical specifications.

E. Substitute Construction Methods or Procedures:

- 1. If a specific means, method, technique, sequence, or procedure of construction is expressly required by the Contract Documents, Contractor may furnish or utilize a substitute means, method, technique, sequence, or procedure of construction approved by ENGINEER.
- 2. Contractor shall submit sufficient information to allow ENGINEER, in ENGINEER's sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents.

F. ENGINEER's Evaluation:

- 1. The Engineer will determine whether or not the material or article submitted is equal to the named material or article. The Engineer's decision regarding evaluation of substitutions shall be final and binding. Request for time extensions and additional costs based on rejection of substitutions will not be allowed.
- 2. ENGINEER will be allowed a reasonable time within which to evaluate each proposal or submittal. ENGINEER may require Contractor to furnish additional data about the proposed substitute item. ENGINEER will be the sole judge of acceptability.
- 3. No "or equal" or substitute will be ordered, installed or utilized until ENGINEER's review is complete, which will be evidenced by either a Change Order for a substitute or an approved Shop Drawing for an "or equal." ENGINEER will advise Contractor in writing of any negative determination.

G. Cost Modifications:

- 1. If the "or-equal" is approved there shall be not increase in the project cost to the OWNER.
- 2. Contractor shall provide all data in support of any proposed substitute or "or-equal" at Contractor's expense.

H. Substitutions will not be considered at any time if:

- 1. Acceptance will require substantial revision of contract documents as determined by the Engineer.

2. Acceptance will create problems in stocking of repair parts and in future maintenance by the Owner.
3. Additional costs may be incurred by the Owner.
4. A time extension is required.

15.0 REQUIRED SUBMITTALS PRELIMINARY

A. For Schedule Which Follows:

1. AB = As-built/Record Documents
2. CE = Certificate
3. CD = Connection diagrams, Electrical
4. CS = Color Selection Chart
5. DM = Design Mix
6. EC = Engineering Computations
7. FI = Field O&M instruction required
8. FT = Field Testing
9. GU = Guarantee
10. LT = Testing Laboratory Test Results
11. MI = Manufacturer's Installation Instructions
12. M/IQ = Manufacturer's/Installers qualifications
13. MR = Manufacturer's Representative at site
14. N/A = Not Available
15. OR = Other; See section requirements
16. OM = O&M Manual
17. PD = Product Data
18. SA = Sample
19. SC = Manufacturer's certification of control schematic
20. SD = Shop Drawing
21. SE = Schematic drawings, Electrical
22. SL = Spares inventory list
23. WA = Warranty

The following submittal schedules are for the CONTRACTORS reference only. The CONTRACTOR is responsible for submitting the required submittals listed in each technical specification.

14.0 SCHEDULE OF REQUIRED SUBMITTALS

A. Supplemental Specifications

SECTION	NAME	REQUIRED
DIVISION 1 - GENERAL REQUIREMENTS		
01 11 00	SUMMARY OF WORK	N/A
01 21 00	ALLOWANCES	FT
01 21 19	TESTING ALLOWANCE	FT, OR
01 29 76	APPLICATION FOR PAYMENT	OR
01 33 00	SUBMITTAL PROCEDURES	N/A
01 57 23	TEMPORARY POLLUTION CONTROL	PD, LT, OR
01 64 00	OWNER SUPPLIED EQUIPMENT	OR
01 71 33	WORK SEQUENCE	OR
01 73 19	INSTALLATION OF WASTEWATER TREATMENT FACILITY EQUIPMENT	FT, OR, CE, FI, MI, MI/Q, MR,
01 74 23	CLEANING	OR
01 77 23	OPERATION AND MAINTENANCE DATA	OM
01 78 39	PROJECT RECORD DOCUMENTS	AB, OR
DIVISION 2 – SITE CONSTRUCTION		
02 41 00	DEMOLITION	OR, AB
DIVISION 3 – CONCRETE		
03 12 00 -	CONCRETE FRAMEWORK	PD
03 21 13 -	REINFORCING STEEL	PD, SD
03 30 00 -	CAST IN PLACE CONCRETE	DM, FT
DIVISION 4 – MASONRY		
04 05 16-	MASONRY GROUTING	PD, FT
04 05 23 -	MASONRY ACCESSORIES	PD, FT
04 20 00 -	UNIT MASONRY	PD, FT
04 22 35	REINFORCED BLOCK MASONRY	PD, FT
DIVISION 7 - THERMAL & MOISTURE PROTECTION		
07 92 00	JOINT SEALANT	PD,SA,CE,M/IQ,LT,WA
07 95 01 -	EXPANSION JOINT SEALANT SYSTEM	PD

SECTION	NAME	REQUIRED
DIVISION 16 - ELECTRICAL SPECIFICATIONS CHINLE		
16010	BASIC ELECTRICAL REQUIREMENTS	SEE DIVISION 16
16110	RACEWAYS	SEE DIVISION 16
16120	WIRES AND CABLES (600v OR LESS)	SEE DIVISION 16
16130	BOXES	SEE DIVISION 16
16140	WIRING DEVICES	SEE DIVISION 16
16195	ELECTRICAL IDENTIFICATION	SEE DIVISION 16
16250	DIESEL ENGINE GENERATOR	SEE DIVISION 16
16260	AUTOMATIC TRANSFER SWITCH	SEE DIVISION 16
16401	SERVICE ENTRANCE SECTION	SEE DIVISION 16
16450	GROUNDING	SEE DIVISION 16
16470	PANELBOARDS	SEE DIVISION 16
16475	OVERCURRENT PROTECTIVE DEVICES	SEE DIVISION 16
16480	MINI POWER CENTERS	SEE DIVISION 16
16481	MOTOR CONTROLLERS	SEE DIVISION 16
16500	LIGHTING	SEE DIVISION 16

DIVISION 31 – EARTHWORK		
31 05 19	GEOGRID FOR EARTHWORK	PD, CE, SD, , WA
31 20 00	EARTHWORK	FT,PD,DM,LT,CE
31 55 00	EARTHWORK RETENTION	FT,PD,DM,LT,CE
DIVISION 33 – UTILITIES		
33 31 15	LARGE DIAMETER PLASTIC SEWER PIPE	CE, FT, OR, PD, AB, SD, WA
DIVISION 35 – WATERWAY CONSTRUCTION		
35 20 16.26	HYDRAULIC SLUICE GATE	CE, OR, PD, AB, SD, WA

B. Standard Specifications

SECTION	NAME	REQUIRED
PART 400 – TRAFFIC CONTROL		
410	FENCES	PD, WA, AB, SD,
PART 600 – WATER AND SEWER		
601	TRENCH EXCAVATION, BACKFILLING, COMPACTION AND FENCING.	DM, FT
615	SEWER LINE CONSTRUCTION	AB, FT, PD
625	MANHOLE CONSTRUCTION AND DROP SEWER CONNECTIONS	AB, FT, PD

PART 2: PRODUCTS

This section not used.

PART 3: EXECUTION

This section not used.

END OF SECTION

ATTACHMENT A
Sample submittal transmittal form.

SAMPLE SUBMITTAL TRANSMITTAL FORM

PROJECT: _____

CONTRACT NUMBER: _____

SUBMITTAL NUMBER: _____ RESUBMITTAL: YES NO

DATE: _____ NUMBER OF COPIES SUBMITTED: _____

SUBMITTAL DESCRIPTION: _____

RELATED DESIGN DISCIPLINE (circle):

Civil Landscape Architectural Structural Mechanical Electrical

Telecommunications Security Fire Protection Controls

Other: _____

ASSOCIATED SPECIFICATION SECTION NO: _____

REFERENCED DRAWING SHEET NO: _____

SUBCONTRACTOR/SUPPLIER/MANUFACTURER PROVIDING SUBMITTAL DATA:

Name: _____

Address: _____

Telephone Number: _____

CONTRACTOR:

Name: _____

Address: _____

Telephone Number: _____

CONTRACTOR'S CERTIFICATION:

The undersigned, as representative of CONTRACTOR for the above Project, submits the following and certifies that:

1. Submittal has been reviewed and it is complete and conforms with requirements of Contract Documents except as noted.
2. Required dimensions have been field verified and are acceptable for installation of proposed products and construction of proposed work.
3. Required quantities for products and materials covered by this submittal have been verified as correct.
4. Fabrication processes and construction methods proposed in this submittal are acceptable for this Project and will result in a complete, functional installation.
5. Submittal has been coordinated with other submittals and work and proposed products and construction will properly interface with other construction.

NAME OF CONTRACTOR REVIEWER: _____

SIGNATURE OF CONTRACTOR REVIEWER: _____

DATE: _____

SUPPLEMENTAL SECTION 01 57 23

TEMPORARY POLLUTION CONTROL

PART 1: GENERAL

1.0 SUMMARY

- A. The work under this section includes compliance with the U.S. Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES) Regulations for Storm Water Discharges Phase II Regulations from construction sites.
- B. The NPDES General Permit, issued by the EPA requires a SWPPP and submittal of NOI and NOT for construction projects with 1 acre or more of earth disturbance. The project will not require a SWPPP or an NOI if the CONTRACTOR will disturb less than 1 acre of earth and the project is not located in the vicinity of perennial streams.
- C. This work consists of developing and implementing and maintaining this plan to control erosion, pollution, sediment and runoff throughout the entire construction of the project.
- D. The contractor shall be responsible for fulfilling all necessary National Pollutant Discharge Elimination System (NPDES) requirements including, but not limited to, obtaining an NPDES permit prior to construction, filling out the Notice of Intent (NOI) application, and filling out the Notice of Termination (NOT) application. The contractor shall also be responsible for the implementation of inspection reports for the Storm Water Pollution Prevention Plan (SWPPP). The contractor shall submit the SWPPP with the proposed construction staging area and temporary sanitary facilities clearly shown to the Engineer. Any check dams, silt fences, or other Best Management Practices (BMPS) that are required in the approved SWPPP shall be included in and are incidental to the SWPPP bid amount.
- E. The contractor shall maintain a copy of the approved SWPPP on-site at all times, and shall comply with the requirements indicated on that plan.
- F. The contractor shall conform to all Navajo Nation and Federal dust and erosion control regulations. The contractor shall prepare and obtain any necessary dust or erosion control permits from the regulatory agencies.

2.0 RELATED WORK

- A. General and Supplemental General Conditions of the Contract and Division 1.

3.0 REFERENCES AND DEFINITIONS

- A. Where all or part of a Federal, ASTM, ANSI, AWWA, Arizona Uniform Standard Specification for Public Works Construction etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.

B. DEFINITIONS:

1. SWPPP: Storm Water Pollution Prevention Plan.
2. BMP: Temporary sediment and erosion control best management practices.
3. EPA: Environmental Protection Agency.
4. NOI: Notice of Intent.
5. NOT: Notice of Termination.
6. NPDES: National Pollutant Discharge Elimination System.
7. NMSHTD: New Mexico State Highway and Transportation Department
8. TЕСP: Temporary Erosion and Sediment Control Plan

4.0 SUBMITTALS

- A. General: Submit listed submittals in accordance with conditions of the Contract and with Specification 01 33 00.
- B. Product Data: Submit product data, including manufacturer's specifications, installation instructions, and general recommendations for installation. Also include manufacturer's certification or other data substantiating that products comply with requirements of Contract Documents. Clearly identify product/model to be used.
- C. Test Reports: Submit for acceptance, complete test reports from approved independent testing laboratories certifying that product conforms to performance characteristics and testing requirements specified herein.
- D. Shop drawings: Submit clear, concise drawing showing model number, size, arrangement and configuration of all products specified. Minimum sheet size is 8.5" X 11".
- E. Reports: The CONTRACTOR shall submit one copy each of the SWPPP, the NOI, site inspection reports, rain event reports and the NOT to the OWNER and ENGINEER as they are completed.

5.0 QUALITY ASSURANCE

This section not used.

6.0 STORAGE AND HANDLING

- A. The CONTRACTOR shall be responsible for the safe storage of the equipment until it is incorporated in the completed project.
- B. The material and equipment shall be stored and handled per the manufacturer's recommendations.

PART 2: PRODUCTS

1.0 SPECIFICATIONS

- A. The CONTRACTOR shall complete an electronic EPA Notice of Intent (NOI) for Storm Water Discharges Associated with Construction Activity Under a NPDES General Permit, Form 3510-9, or a Low Erosivity Waiver (LEW) form, if applicable, as directed on the EPA website:

<http://cfpub.epa.gov/NPDES/stormwater/enoi.cfm>

- B. A LEW is applicable to short-term (generally less than 8 months) construction projects that disturb an area of 1 to 5 acres during the dry season (mid-October to mid-June). Submission of a LEW exempts CONTRACTORS from preparation of a storm water pollution prevention plan (SWP3). CONTRACTORS may use the calculation tool on the EPA website to determine whether or not the site is eligible for a LEW:

<http://cfpub.epa.gov/npdes/stormwater/lew/lewcalculator.cfm>

- C. Note that routine maintenance projects, regardless of size, are exempt from submission of either a LEW or NOI as well as preparation of a SWP3. Routine maintenance projects are classified as those activities performed to maintain the original line and grade, hydraulic capacity, or original purpose of the site. Such activities include water/sewer line breaks, street millings and overlays, replacement of water meter boxes, replacement of curb and gutter, etc.
- D. The CONTRACTOR shall also submit, at least seven days prior to ground disturbance, a hard copy of the completed NOI form or a hard copy of the LEW form and one (1) copy of the Storm Water Pollution Prevention Plan (SWP3) to both of the following addresses:

Allena Muskett
Smith Engineering Company
2201 San Pedro NE
Building 4, Suite 200
Albuquerque, NM 87110

Thomas Bayles
NTUA
P.O. Box 170
Ft. Defiance, AZ 86504-0170

- E. By completing an NOI, the CONTRACTOR is certifying to the OWNER that a SWP3 has been completed as per the NPDES Permit and is in the CONTRACTOR'S possession and one copy has been submitted.
- F. The CONTRACTOR is the designated "Operator" of the NPDES Permit, and is solely responsible for execution of the project construction in conformance with NPDES Permit condition(s) and

requirement(s), including work performed by any subCONTRACTOR(s). The CONTRACTOR shall immediately correct conditions related to the project that are in violation of NPDES permit requirements. Failure by the CONTRACTOR to correct such conditions in a timely manner may subject the CONTRACTOR to fines and/or penalties.

- G. The CONTRACTOR shall indemnify, defend and hold the OWNER harmless from any fines and/or penalties issued for violations of NPDES Permit conditions.
- H. In the event the CONTRACTOR fails to comply with NPDES Permit requirements, the OWNER retains the right to enter upon the project site and perform corrective measures. Any costs associated with corrective measures shall be the responsibility of, and shall be paid by, the CONTRACTOR. The OWNER shall be entitled to deduct such costs from remaining contract amounts, and if insufficient contract amounts exist, the CONTRACTOR shall reimburse the OWNER for any deficiency.
- I. An electronic EPA Notice of Termination (NOT) of Coverage Under a NPDES General Permit for Storm Water Discharges Associated with Construction Activity, Form 3510-13, will be completed by the CONTRACTOR at the website in Paragraph A above, and a copy to the addresses in Paragraph E above after final acceptance of the project construction by the OWNER
- J. Temporary Erosion and Sediment Control Plan: The CONTRACTOR shall develop a Temporary Erosion and Sediment Control Plan (TESCP) which depicts the location and type of temporary erosion control measures.
- K. The CONTRACTOR shall construct the control facilities and maintain them until project completion.

2.0 MATERIALS

- A. General: Provide Materials for erosion and sediment control measures that consist of siltation fences, socks, rock, riprap, soil retention blankets, or other acceptable measures approved by the ENGINEER.
- B. Slope Drains: Provide Materials for slope drains that consist of pipe, flexible pipe, and riprap. The ENGINEER may approve the use of other Materials.
- C. Riprap: Provide riprap and rock plating in accordance with Standard Specification 220.
- D. Mulch Socks or Composted Mulch Socks
 - 1. Core Material (woodchips): The Material must be 100% untreated wood chip and free of inorganic debris, such as plastic, glass, metal, etc. Manufacturer shall certify that the material is free of noxious weeds.
 - 2. Woodchip size shall not be smaller than 1 inch and shall not exceed 3 inches in diameter; shavings shall not be more than 5% of the total mass.
 - 3. Containment Mesh: Furnish containment mesh 100% biodegradable, photodegradable such as burlap, twine, UV photodegradable plastic, polyester, or other acceptable Material as

directed by the Project Manager. The mesh should not exceed 1/2 inches in diameter.

4. Furnish biodegradable or photodegradable containment mesh when the socks will remain in place as part of the permanent or temporary vegetative plan. The containment mesh shall be greater than 9 inches in height after being packed; the containment mesh shall be densely packed so that the socks do not deform. The Project Manager will determine the maximum allowable height for containment mesh.

3.0 PRE-APPROVED MANUFACTURERS

This section not used.

PART 3: EXECUTION

- A. Before disturbing any soil, submit to the ENGINEER a SWPPP based on the planned construction phasing and schedule.
- B. Prepare amendments to the SWPPP as Work progresses or as phasing or scheduling changes are made. Specifically define control measures for each construction phase, comply with provisions of the NPDES General Permit.
- C. Retention of Records: Retain and maintain SWPPP changes as required by the NPDES General Permit. Include copies of the permit language and inspection and maintenance reports in the SWPPP. Prepare inspection and maintenance reports from commencement of earthwork activities to project completion. Deliver the final SWPPP to the ENGINEER at project completion. Ensure that these records are available to the public at all times.
- D. Inspection Frequency: The CONTRACTOR must conduct inspections in accordance with one of the two schedules listed below and submit to the ENGINEER a report of each inspection. The CONTRACTOR must specify in your SWPPP which schedule you will be following.
 1. At least once every 7 calendar days, OR
 2. At least once every 14 calendar days and within 24 hours of the end of a storm event of 0.5 inches or greater.
- E. The contractor shall either promptly remove any material excavated within the project site or install BMPS identified in the approved SWPPP to prevent discharge of excavated material within the project site during a rain or wind event.
- F. The contractor shall ensure that no soil erodes from the site onto other property by installing BMPS identified in the approved SWPPP at the property lines.
- G. The contractor shall mitigate erosion of temporary or permanent dirt swales by installing BMPS identified in the approved SWPPP in the swales perpendicular to the direction of flow, and the intervals as specified in the SWPPP.

- H. Construction areas shall be watered for dust control in compliance with government ordinances. The contractor shall be responsible for locating and supplying water as required. Watering, as required for construction and dust control, shall be considered incidental to construction and no measurement or payment shall be made therefore.
- I. The contractor shall comply with all applicable regulations concerning surface and underground water. Contact with surface water by construction equipment and personnel shall be minimized. Equipment maintenance and refueling operations shall be performed in an environmentally safe manner in compliance with government regulations.
- J. Where storm inlets are susceptible to inflow of silt or debris from construction activities, protection shall be provided on their upstream side utilizing BMPS identified in the approved SWPPP.
- K. The contractor shall implement the approved SWPPP and ensure that no soil erodes from the site into public right-of-way or onto private property.

1.0 CONTRACTOR'S RESPONSIBILITY

- A. The CONTRACTOR is responsible for furnishing and installing the PRODUCT including all site preparation, and other items necessary for the proper installation and operation of the PRODUCT.

2.0 EXAMINATION

- A. Examine all products for compliance with this section.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Verify that the PRODUCT dimensions and materials are correct and project conditions are suitable for installation. Do not proceed with installation until conditions deficiencies have been corrected.

3.0 PREPARATION

This section not used.

4.0 INSTALLATION

- A. General: Install temporary erosion and sediment control features for the duration of the construction period. Incorporate erosion and sediment control measures into the project at the earliest practical time.
- B. Keep construction areas in an orderly condition and promptly dispose of refuse and discarded materials.
- C. Repair damaged erosion and sediment control installations within three days of damage.
- D. Maintain erosion and sediment control features until the project is completed.

E. Remove and dispose of erosion and sediment control installations at Substantial Completion of the project.

5.0 OPERATIONS AND MAINTENANCE MANUALS – NOT USED

6.0 WARRANTY – NOT USED

END OF SECTION

SUPPLEMENTAL SECTION 01 64 00

OWNER SUPPLIED PRODUCTS

PART 1: GENERAL

1.0 SUMMARY

- A. The Contractor shall install the following equipment packages that have been pre-purchased by the Owner in a separate Agreement. The Contractor shall review the Related Work referenced in herein to fully complete the work required. The Contractor shall use the Specifications and attachments herein to fully execute the work required to handle, store, install, test, and startup the systems.
- B. For all aerators, a copy of the manufacturer's O&M manual is attached to this section; **ATTACHMENT 1.**

1. Chinle Waste Water Treatment Plant Cell #2 Aerators

- a) This package consists of:
- i. 6-25 HP Aire-O₂ Aspirating Aerators
 - a. 25-HP, TEFC, 230/460 volt, 3 phase, 60 Hz, 1800 RPM NEMA motor
 - b. Field replaceable, water lubricated lower bearing
 - c. Field replaceable, wear resistant sleeve
 - d. 304 Stainless steel three-bladed propeller
 - e. 304 Stainless steel diffuser, housing, and hollow shaft
 - ii. 1-15 HP Aire-O₂ Aerator
 - a. 15-HP TEFC, 230/460, 3 phase, 60 Hz, 1800 RPM NEMA motor
 - b. Field replaceable, water lubricated lower bearing
 - c. Field replaceable, wear resistant sleeve
 - d. 304 Stainless steel three-bladed propeller
 - e. 304 Stainless steel diffuser, housing, and hollow shaft
 - iii. 7 Quad-Float Assemblies
 - a. 3 molded low density polyethylene, closed cell foam filled, pontoons
 - b. Hot dipped galvanized steel rails and mounting hardware

c. Floating vortex shield cabled to the frame

iv. Control Panel

v. Miscellaneous

- a. 4/4 SEO-OW Electrical Cable
- b. 4-Hot-dipped Galvanized Inline Mounts (2 for existing units)
- c. Spool 3/8" Stainless steel mooring cable
- d. 3/8" SS Mooring cable end assemblies
- e. 3/8" SS Mooring cable turnbuckles
- f. 15 Hp Propeller Removal Tool
- g. 25 Hp Propeller Removal Tool

vi. Spare Parts

- a. Mini-Kit 15 Hp consisting of:
 - i. 1 abrasion resistant bearing
 - ii. 2 Nylon washers
 - iii. 1 Ceramic sleeve
- b. Mini-Kit 25 Hp consisting of:
 - i. 1 abrasion resistant bearing
 - ii. 2 Nylon washers
 - iii. 1 Ceramic sleeve

b) The Contractor will be required to install the equipment in the locations as shown on the Drawings.

2. Pinon Waste Water Treatment Plant Cell #1 and #2 Aerators

- a) This package consists of:
 - i. 1-25 HP Aire-O₂ Aspirating Aerators (Cell #1)
 - a. 25-HP, TEFC, 230/460 volt, 3 phase, 60 Hz, 1800 RPM NEMA motor

- b. Field replaceable, water lubricated lower bearing
 - c. Field replaceable, wear resistant sleeve
 - d. 304 Stainless steel three-bladed propeller
 - e. 304 Stainless steel diffuser, housing, and hollow shaft
- ii. 3-15 HP Aire-O₂ Aspirating Aerators (Cell #1)
- a. 15-HP, TEFC, 230/460 volt, 3 phase, 60 Hz, 900 RPM motor
 - b. Field replaceable, water lubricated lower bearing
 - c. Field replaceable, wear resistant sleeve
 - d. 316 SS Dual-bladed primary PowerMix propeller
 - e. 304 SS Saturn Ring Diffuser
 - f. 304 Stainless steel diffuser, housing, and hollow shaft
- iii. 4-15 HP Aire-O₂ Aerator (Cell #2)
- a. 15-HP TEFC, 230/460, 3 phase, 60 Hz, 900 RPM motor
 - b. Field replaceable, water lubricated lower bearing
 - c. Field replaceable, wear resistant sleeve
 - d. 316 SS Dual-bladed primary PowerMix propeller
 - e. 304 Stainless steel Saturn Ring Diffuser
 - f. 304 Stainless steel diffuser, housing, and hollow shaft
- iv. 8 Quad-Float Assemblies
- a. 3 molded low density polyethylene, closed cell foam filled, pontoons
 - b. Hot dipped galvanized steel rails and mounting hardware
 - c. Vortex shield attached to aerator housing
- v. Packaged Control Panel
- vi. Miscellaneous
- a. 2/4 SEO-OW Electrical Cable
 - b. 1-Hot-dipped Galvanized Inline Mounts

- c. Spool 3/8" Stainless steel mooring cable
- d. 3/8" SS Mooring cable end assemblies
- e. 3/8" SS Mooring cable turnbuckles

vii. Spare Parts

- a. Mini-Kit 15 Hp consisting of:
 - i. 1 abrasion resistant bearing
 - ii. 2 Nylon washers
 - iii. 1 Ceramic sleeve
- b. Mini-Kit 25 Hp consisting of:
 - i. 1 abrasion resistant bearing
 - ii. 2 Nylon washers
 - iii. 1 Ceramic sleeve

- b) The Contractor will be required to install the equipment in the locations as shown on the Drawings.

3. Kayenta Waste Water Treatment Plant Cell #1B Aerators

- a) This package consists of:
 - i. 2-25 HP Aire-O₂ Aspirating Aerators
 - a. 25-HP, TEFC, 230/460 volt, 3 phase, 60 Hz, 900 RPM motor
 - b. Field replaceable, water lubricated lower bearing
 - c. Field replaceable, wear resistant sleeve
 - d. 316 SS Dual-bladed primary PowerMix propeller
 - e. 304 SS Saturn Ring Diffuser
 - f. 304 Stainless steel diffuser, housing, and hollow shaft
 - ii. 3-15 HP Aire-O₂ Aerator
 - a. 15-HP TEFC, 230/460, 3 phase, 60 Hz, 900 RPM motor
 - b. Field replaceable, water lubricated lower bearing
 - c. Field replaceable, wear resistant sleeve

- d. 316 SS Dual-bladed primary PowerMix propeller
 - e. 304 Stainless steel Saturn Ring Diffuser
 - f. 304 Stainless steel diffuser, housing, and hollow shaft
- iii. 3-10 HP Aire-O₂ Aspirating Aerators
- a. 10-HP TEFC, 230/460, 3 phase, 60 Hz, 900 RPM motor
 - b. Field replaceable, water lubricated lower bearing
 - c. Field replaceable, wear resistant sleeve
 - d. 316 SS Dual-bladed primary PowerMix propeller
 - e. 304 Stainless steel Saturn Ring Diffuser
 - f. 304 Stainless steel diffuser, housing, and hollow shaft
- iv. 8 Quad-Float Assemblies
- a. 3 molded low density polyethylene, closed cell foam filled, pontoons
 - b. Hot dipped galvanized steel rails and mounting hardware
 - c. Vortex shield attached to aerator housing
- v. Packaged Control Panel
- vi. Miscellaneous
- a. 2/4 SEO-OW Electrical Cable
 - b. 1-Hot-dipped Galvanized Inline Mounts
 - c. Spool 3/8" Stainless steel mooring cable
 - d. 3/8" SS Mooring cable end assemblies
 - e. 3/8" SS Mooring cable turnbuckles
- vii. Spare Parts
- a. Mini-Kit 10 Hp consisting of:
 - i. 1 abrasion resistant bearing
 - ii. 2 Nylon washers
 - iii. 1 Ceramic sleeve

- b. Mini-Kit 15 Hp consisting of:
 - i. 1 abrasion resistant bearing
 - ii. 2 Nylon washers
 - iii. 1 Ceramic sleeve
- c. Mini-Kit 25 Hp consisting of:
 - i. 1 abrasion resistant bearing
 - ii. 2 Nylon washers
 - iii. 1 Ceramic sleeve

4. Ganado Waste Water Treatment Plant Cell #1 Aerators

- a) This package consists of:
 - i. 3-25 HP Aire-O₂ Aspirating Aerators
 - a. 25-HP, TEFC, 230/460 volt, 3 phase, 60 Hz, 1800 RPM motor
 - b. Field replaceable, water lubricated lower bearing
 - c. Field replaceable, wear resistant sleeve
 - d. 316 SS Dual-bladed primary PowerMix propeller
 - e. 304 SS Saturn Ring Diffuser
 - f. 304 Stainless steel diffuser, housing, and hollow shaft
 - ii. 3 Quad-Float Assemblies
 - a. 3 molded low density polyethylene, closed cell foam filled, pontoons
 - b. Hot dipped galvanized steel rails and mounting hardware
 - c. Vortex shield attached to aerator housing
 - iii. Packaged Control Panel
 - iv. Miscellaneous
 - a. 2/4 SEO-OW Electrical Cable
 - b. 1-Hot-dipped Galvanized Inline Mounts
 - c. Spool 3/8" Stainless steel mooring cable

- d. 3/8" SS Mooring cable end assemblies
- e. 3/8" SS Mooring cable turnbuckles

v. Spare Parts

- a. Mini-Kit 25 Hp consisting of:
 - i. 1 abrasion resistant bearing
 - ii. 2 Nylon washers
 - iii. 1 Ceramic sleeve

- b) The Contractor will be required to install the equipment in the locations as shown on the Drawings.

5. TUBA CITY Waste Water Treatment Plant Cell #1 Aerators

- a) This package consists of:
 - i. 9-25 HP Aire-O₂ Aspirating Aerators
 - a. 25-HP, TEFC, 230/460 volt, 3 phase, 60 Hz, 1800 RPM motor
 - b. Field replaceable, water lubricated lower bearing
 - c. Field replaceable, wear resistant sleeve
 - d. 316 SS Dual-bladed primary PowerMix propeller
 - e. 304 SS Saturn Ring Diffuser
 - f. 304 Stainless steel diffuser, housing, and hollow shaft
 - ii. 9 Quad-Float Assemblies
 - a. 4 molded low density polyethylene, closed cell foam filled, pontoons
 - b. Hot dipped galvanized steel rails and mounting hardware
 - c. Vortex shield attached to aerator housing
 - iii. Packaged Control Panel
 - iv. Miscellaneous
 - a. 2/4 SEO-OW Electrical Cable
 - b. 3-Hot-dipped Galvanized Inline Mounts

- c. Spool 3/8" Stainless steel mooring cable
- d. 3/8" SS Mooring cable end assemblies
- e. 3/8" SS Mooring cable turnbuckles

C. All related costs to decommission and completely install and put in operation the Owner-Supplied equipment listed above shall be included in Contractor's Bid. Failure to include any such items in the Bid shall not result in a change in the Contract amount.

2.0 REFERENCES AND DEFINITIONS

A. Where all or part of a Federal, ASTM, ANSI, AWWA, and Arizona Uniform Standard Specification for Public Works Construction etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.

B. Definitions:

1. "Manufacturer/Supplier" refers to the person, firm, or corporation of whom supplied the equipment originally.
2. "Transfer" of Owner-supplied equipment, submittals, and instructions to the Contractor refers to the times when the following have occurred:
 - a) Manufacturer/Supplier's instructions for handling, storage, and protection have been obtained by the Contractor.
 - b) Manufacturer/Supplier's instructions for equipment decommissioning have been obtained by the Contractor.
 - c) Notice of Equipment Delivery Date for refurbished equipment has been received by Owner and Contractor.
 - d) Manufacturer/Supplier's instructions for equipment installation have been obtained by the Contractor.
 - e) Installation Inspection has been conducted jointly by the Owner and Contractor.
 - f) Manufacturer/Supplier's instructions for startup and commissioning have been received by the Contractor.

3.0 RELATED WORK SPECIFIED ELSEWHERE:

1. General and Supplemental General Conditions of the Contract and Division 1.

2. Section 01 33 00: Submittal Procedures

4.0 SUBMITTALS

- A. General: Submit listed submittals in accordance with conditions of the Contract and with Specification 01 33 00.
- B. For each piece of Owner supplied equipment, Contractor shall submit a complete schedule and procedure for removal, shipping, storage, reinstallation and testing of the equipment.
- C. Contractor shall inspect, review, and concur with all equipment condition, operations, and performance documentation jointly with the Manufacturer/Supplier and Owner. Contractor shall submit the Certificate of Equipment Performance.
- D. Contractor shall submit a written equipment decommissioning plan in accordance with all Manufacturer/Supplier instructions.
- E. Contractor shall submit the Notice of Equipment Delivery Date for refurbished equipment.
- F. Contractor shall conduct an Installation Inspection and submit the Certificate of Proper Installation in accordance with all Manufacturer/Supplier instructions.

5.0 SEQUENCING AND SCHEDULING

- A. For each system listed herein, the Contractor shall:
 - 1. Review the attached Manufacturer/Supplier's instructions for handling, storage, and protection.
 - 2. Inspect, review, and concur with all equipment condition, operations, and performance documentation jointly with the Owner.
 - 3. Review the Manufacturer/Supplier's instructions for equipment decommissioning.
- B. The equipment shall not be transferred until the structure and utilities that they are going to be located are complete and ready for final equipment installation.
- C. Contractor shall fully coordinate inspection, delivery, and startup activities for the Owner-Supplied Equipment in accordance with STS 01 73 19, Installation of Wastewater Treatment Facility Equipment.

6.0 CONTRACTOR'S RESPONSIBILITY FOR COMPLETE SYSTEM

- A. Contractor shall have complete responsibility for all necessary storing, handling, installing, adjusting, and maintaining Owner-Supplied equipment once transfer is complete.

- B. Contractor shall provide and coordinate the construction and installation of interconnecting structures, equipment, piping, electrical and instrumentation work, and appurtenances to install and operate the Owner-Supplied equipment as depicted and specified herein, and as required to provide a complete and functional system.

PART 2: PRODUCTS

1.0 SPECIFICATION

- A. Provide products required to complete the work under this Section, except where specifically specified as Owner supplied or Owner furnished.
- B. Such products include, but are not limited to connecting piping, valves, hangers, and supports, inserts, anchor bolts, motor starters, wiring, piping accessories, specialties, finish painting, and expendable materials, all as necessary to provide a complete and properly functioning system.

2.0 EQUIPMENT

- A. Miscellaneous Products:
 - 1. Furnish incidental products, such as gaskets, supports, bolts, and miscellaneous lubricants, as required for proper operation of equipment installed under this Section.

PART 3: EXECUTION

1.0 GENERAL

- A. Installation work shall conform to Manufacturer's procedures, instructions, and shop drawings, as reviewed and approved by the Engineer and the Owner.
- B. Loading, transport to its place of installation, unload, inspect, store, handle, and protect , reinstall, and start up Owner supplied equipment.
- C. Install piping, conduit, wiring, cables and miscellaneous fittings included with Owner supplied equipment in accordance with Manufacturer/Supplier's instructions and with the Division 15 & 16 specifications.

2.0 EXAMINATION (PRIOR TO TRANSFER)

- A. Before transfer of Owner supplied equipment to the Contractor, the Owner and the Contractor shall jointly inspect the condition of each product. This will be completed a minimum of 72 hours prior to transfer. Contractor shall take digital photos to record the condition of the equipment.
- B. If during the inspection, it is determined that the equipment is damaged or deficient, the Contractor shall coordinate with the Owner regarding repairs. The Owner shall execute, or cause to be executed, such actions, repairs, replacements, etc. necessary to remediate any damages/deficiencies identified.

- C. Contractor shall record (written list of equipment items and photos) the products transferred. All records, such as described shall be maintained onsite.
- D. Damage or loss of equipment and materials after the date of their transfer to the Contractor shall be repaired or replaced at the Contractor's expense.

3.0 STORAGE AND HANDLING

- A. Following transfer of Owner supplied equipment and until final acceptance of the completed work, Contractor shall protect and maintain products to prevent damage in accordance with Manufacturer instructions.
- B. Contractor shall repair damage to or replace loss of all equipment to equal to or better than new conditions after the date of their transfer to Contractor, as reviewed and accepted by Owner.
- C. Contractor and Owner shall inspect the equipment for signs of pitting, rust decay, or other deleterious effects of improper storage just before installation, and shall notify Owner of the results of the inspection.

4.0 INSTALLATION

- A. Contractor shall provide supervision, labor, tools, construction equipment, incidental materials, and necessary services required to install the Owner supplied equipment in accordance with Manufacturer/Supplier's instructions.

5.0 FIELD QUALITY CONTROL

- A. Functional Test:
 - 1. Verify that proper mechanical and electrical connections have been made.
 - 2. Correct defects in installation as required by Manufacturer/Supplier's instructions and recommendations.
 - 3. If, in the opinion of the Owner, the system meets the requirements specified, the system Performance Test will be conducted.
 - 4. If system fails functional test, make such adjustments, changes, and/or additions as are necessary to correct the system and retest it.

6.0 WARRANTY

- A. The work shall be warranted against defects in material and workmanship for a period of one year. The warranty period shall begin after final inspection and acceptance by the project ENGINEER.

END OF SECTION

ATTACHMENT 1 Manufacturer's O&M Manual

EQUIPMENT CUT SHEET



**Aeration
Industries®**

AIRE-O₂® Aspirator Aerator Aerator 1030 Series

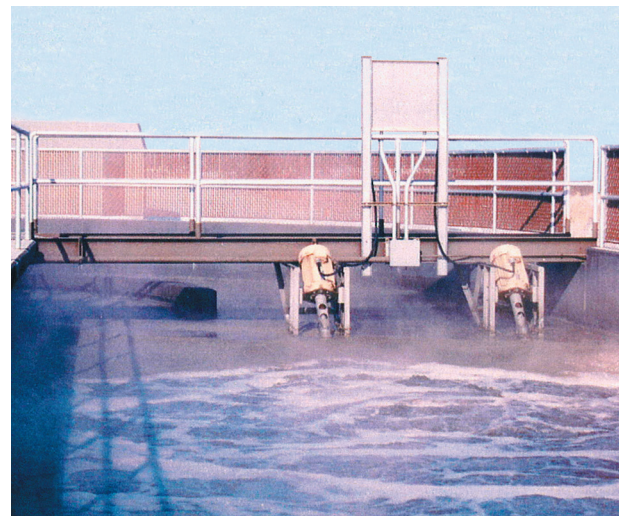
The Trusted Industry Workhorse Since 1974

The Aire-O₂® aerator is a high quality, minimal maintenance aspirator aerator with superior performance and a proven record. Aeration Industries International developed and introduced the innovative, patented aspirator aeration technology in 1974. The aerator creates a high velocity stream of oxygen that keeps solids in suspension and in contact with the plume of fine bubbles. A series of strategically placed units creates "flow linkage," providing whole basin aeration and circulation that prevents short-circuiting. More than 65,000 Aire-O₂® aerators have been installed throughout the U.S. and over 92 countries worldwide.

AIRE-O₂® Aspirator Aerator Benefits:

- Increased mixing and fine bubble oxygen dispersion.
- Low capital cost investment.
- Large range of Hp sizes adaptable to numerous applications, processes and configurations.
- Adjustable angle of entry allows for shallow to deep applications.
- Ease of installation, portability and minimal maintenance.
- Winter treatment performance efficiency.
- No aerosols or odors, "community friendly."
- Ideal for retrofits and upgrades.
- Three (3) Year Warranty.

Available in 10-30 Hp (7.5-22 kW) sizes in worldwide voltage, phase, Hz combinations.



Satisfied 20+ year customer says:

"The 8 aerators allow for a turn down in oxygen transfer capability while assuring complete mixing of the ditch under all load conditions. We like the Aire-O₂ system. Maintenance is easy."

Madison WWTP, SD



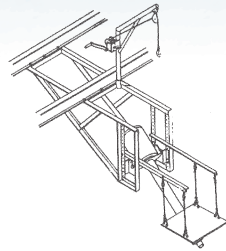
*Aire-O₂ aerators pictured mounted on floats.
Bridge mounting shown above.*

AIRE-O₂[®] Aspirator Aerator

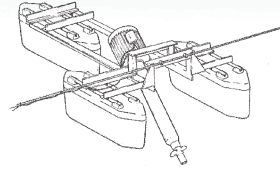
1030 Series

Mounting Options:

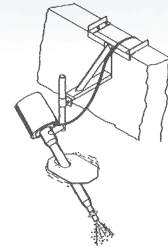
For anchor mounting details please contact the factory.



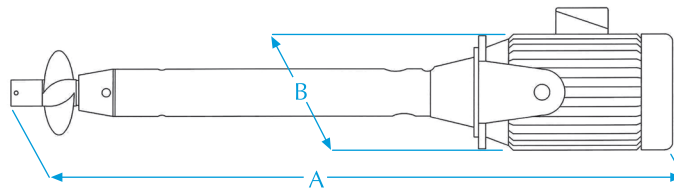
Bridge Mount



Float Mount



Wall Mount



60 / 50 Hz Weights & Measures for the 1030 Series AIRE-O₂[®] Aerator:

NEMA AND IEC Motors Available

Hp	kW	Dimensions		60 Hz	50 Hz	Ship Weight	Pontoon System Available	Pontoon System
		A	B	Motor Nominal RPM	Motor Nominal RPM			
10	7.5	65 (1.65)	11 (.23)	1800	1500	360 (163)	a	a Tri-pontoon
15	11	71 (1.80)	12 (.31)	1800	1500	465 (211)	a	b Quad-pontoon
20	15	71 (1.80)	12 (.31)	1800	1500	470 (213)	a	
25	18.5	73 (1.85)	12 (.31)	1800	1500	720 (327)	a, b	
30	22	73 (1.85)	12 (.31)	1800	1500	769 (349)	a, b	

Pontoon systems available for 50 Hz / 60 Hz may vary. Contact factory.

RPM and SHIP WEIGHTS may vary between motor manufacturers.

Data subject to change without notice.

For estimate only - consult factory.



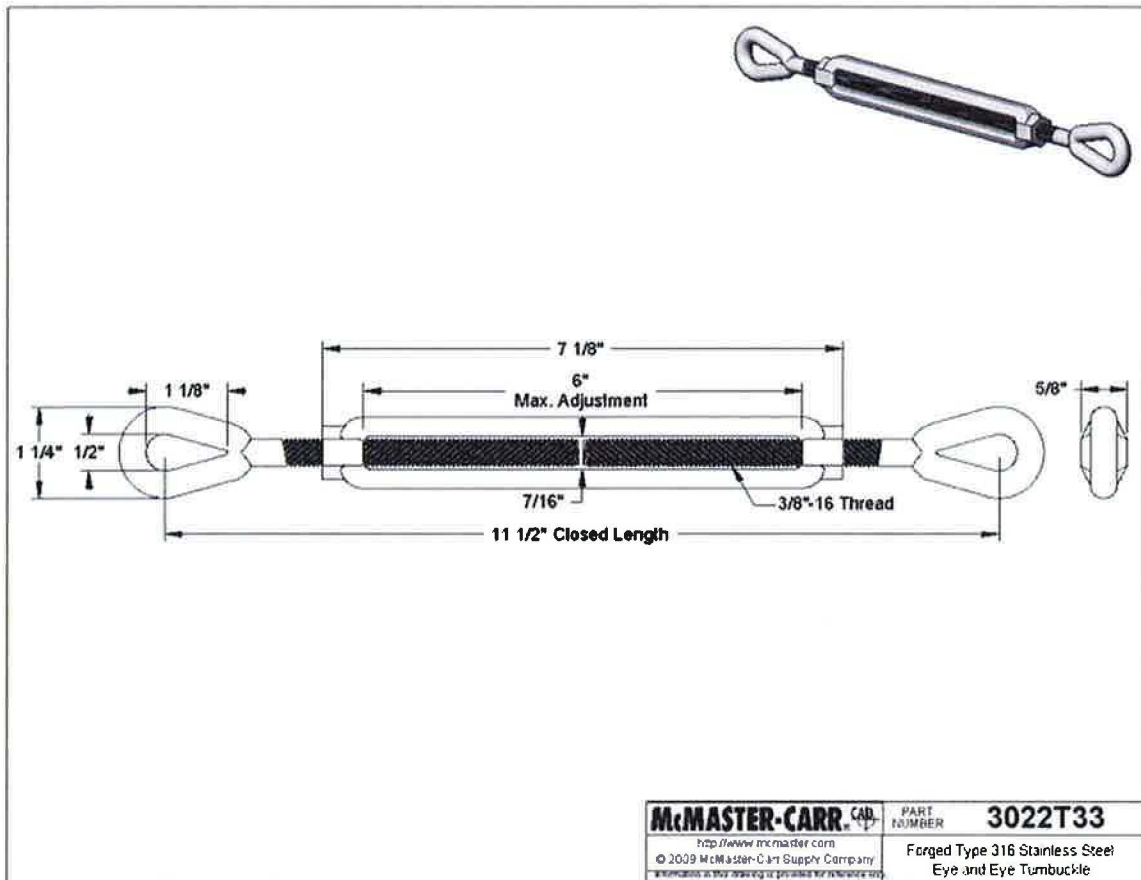
Aeration Industries[®]

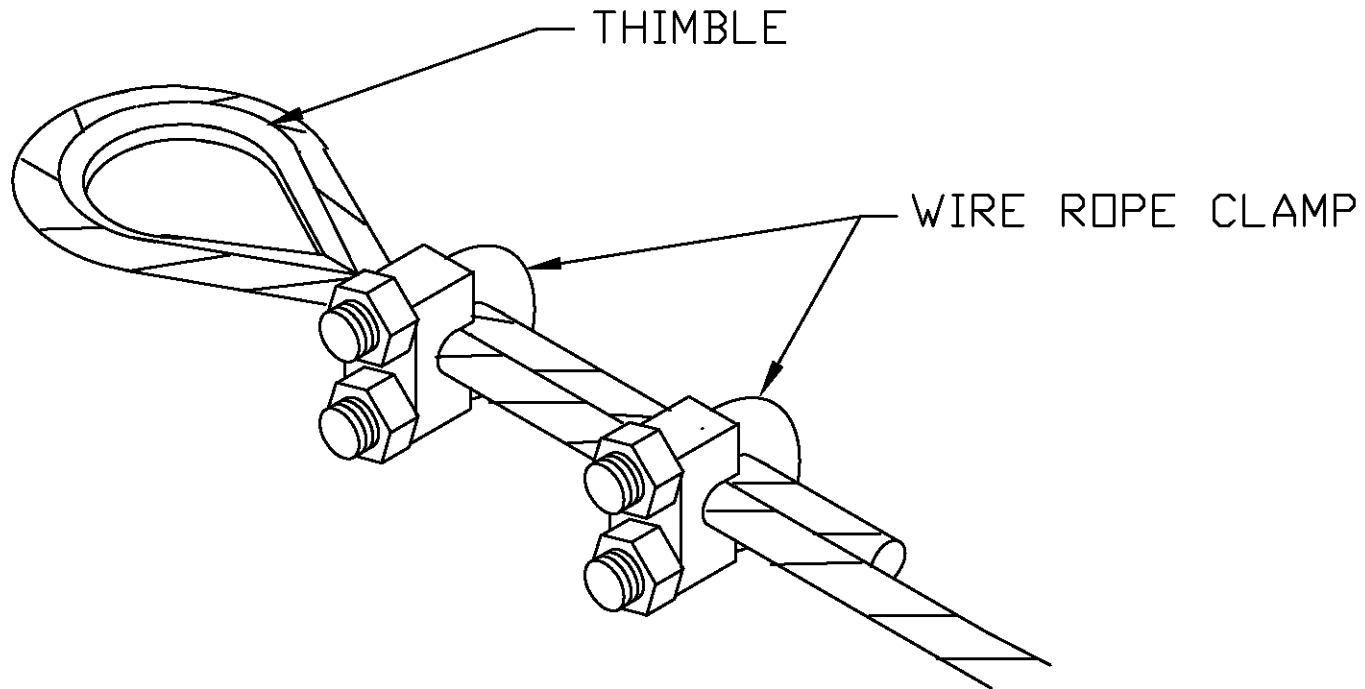
Aeration Industries International
 4100 Peavey Road • Chaska, Minnesota 55318-2353 USA
 +1-952-448-6789 / +1-800-328-8287 (USA) / FAX +1-952-448-7293
www.aireo2.com • aiii@aireo2.com

Turnbuckles


Part Number: **3022T33**1-5 Each \$51.30 Each
6 or more \$47.68 Each

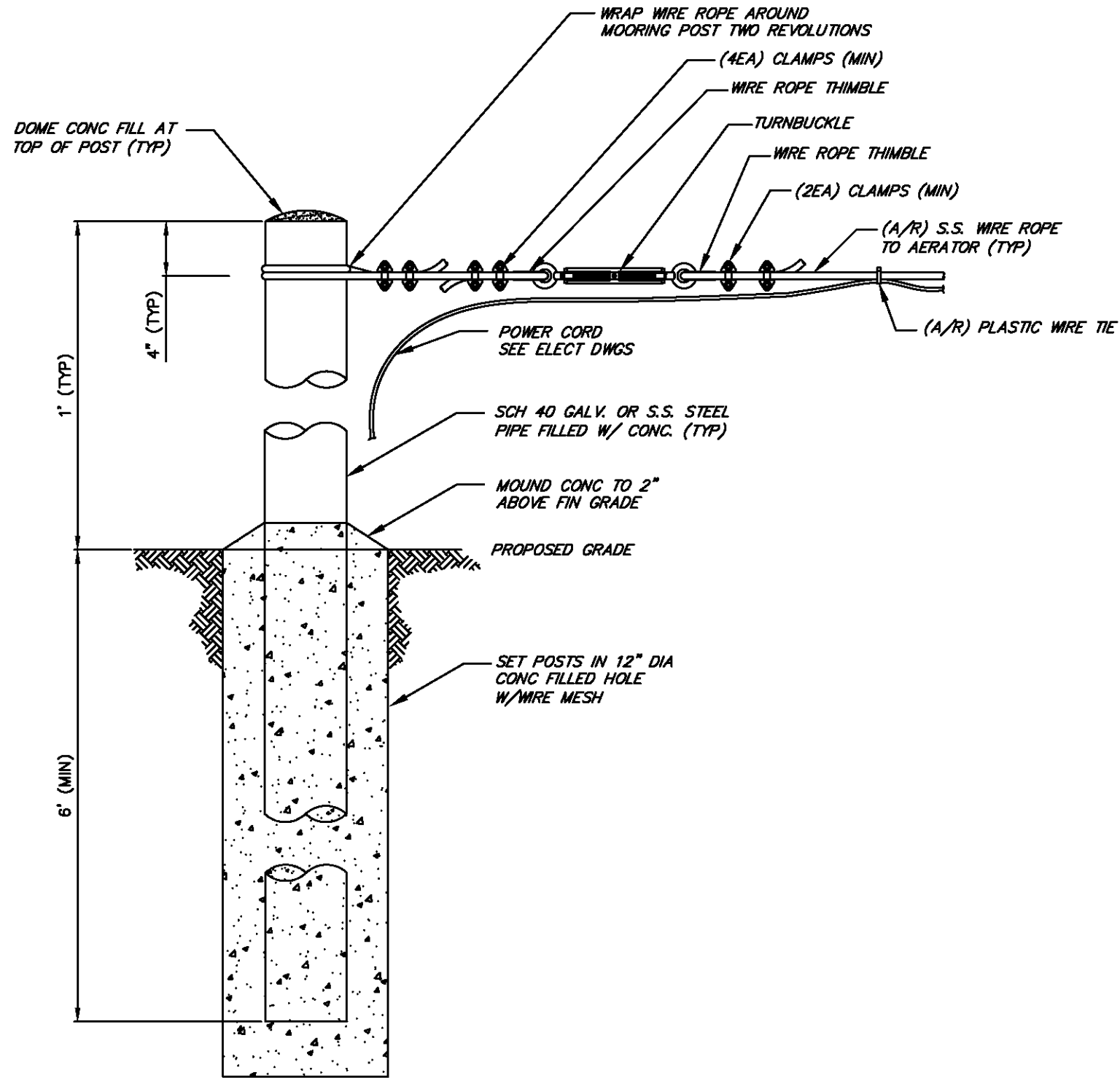
Type	Eye and Eye Turnbuckles
Body Style	Open Body
Round Eye Style	Oval Eye
Material	Forged Type 316 Stainless Steel
Thread Size	3/8"-16
Work Load Limit	1,200 lbs.
Eye Inside Diameter	1/2"
Eye Length	1-1/8"
Maximum Adjustment	6"
Closed Length	11"
Specifications Met	American Society for Testing and Materials (ASTM)
ASTM Specifications	ASTM F1145-92, Type 1
WARNING	Never exceed work load limits for this item.



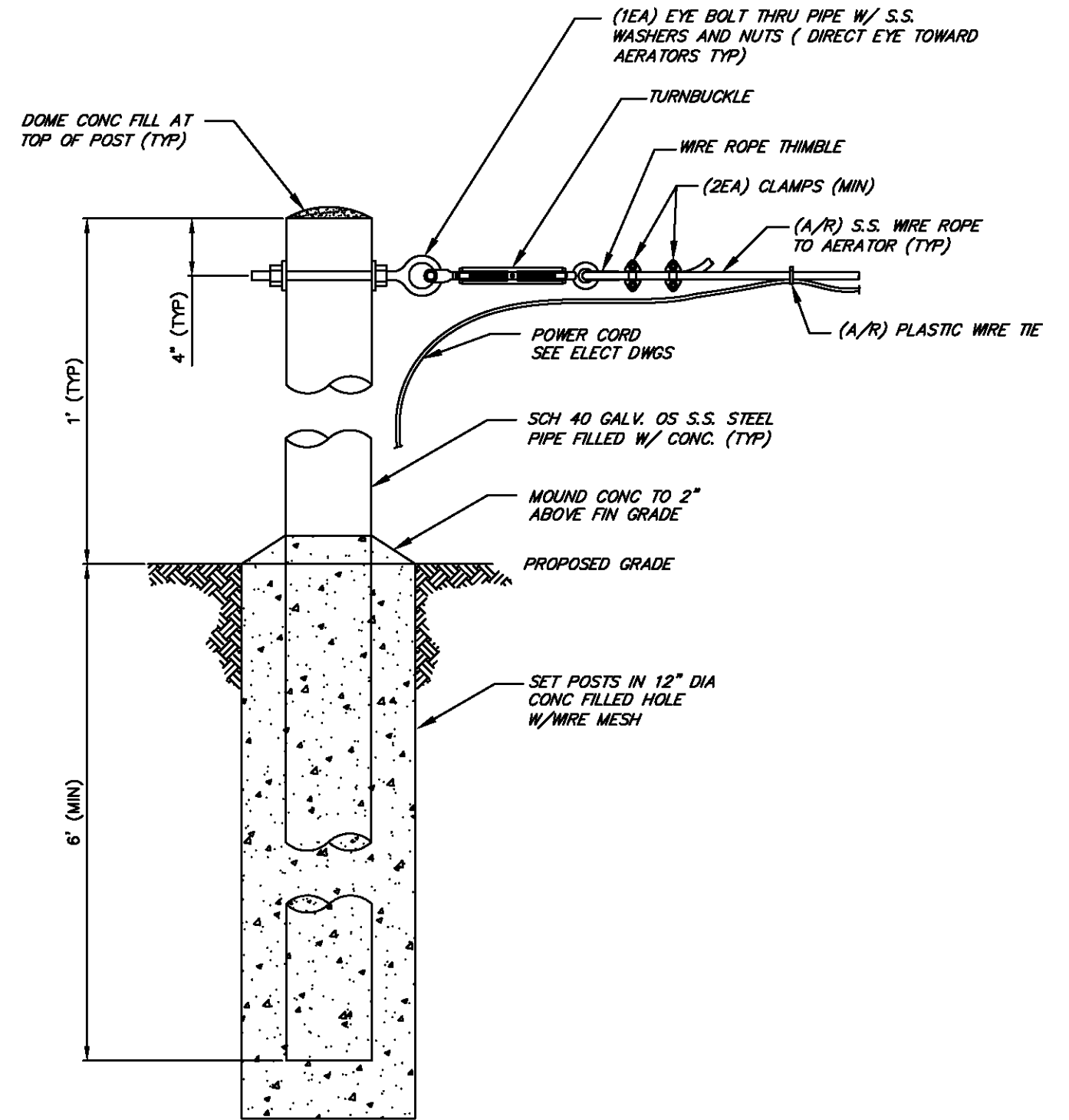


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		 Aeration Industries International, Inc. P.O. Box 59144 Minneapolis, MN 55459 USA Telephone: 1(612)448-8789 Telex: 9105780838 Facsimile: 1(612)448-7293		
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DATE		SCALE	PLOT	SHEET
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			5	1




METHOD W/O EYE-BOLT



METHOD WITH EYE-BOLT

NOTE:
THIS IS A DESIGN RECOMMENDATION FOR A TYPICAL INSTALLATION ONLY. FINAL DESIGN IS THE RESPONSIBILITY OF THE ONSITE CONTRACTOR/CIVIL ENGINEER AFTER ACTUAL SITE CONDITIONS ARE ANALYZED.

TYPICAL MINIMUM SOIL REQUIREMENTS:
COMPRESSED SATURATED GRANULAR WITH AN ALLOWABLE BEARING PRESSURE OF 1000 PSF. DO NOT PLACE IN ORGANIC SOIL (BLACK DIRT, PEAT, ETC.) OR LOOSE SAND.

		Aeration Industries International, LLC. P.O. Box 59144 Minneapolis, MN 55459 USA Telephone: 1(952)448-6789 Fax: 1(952)448-7293	
		TITLE MOORING POST DETAILS TYPICAL INSTALLATION	
DRAWN NSF	DATE 10-6-10	PROJECT NO. SK11-002	REV. -
REVISED 	DATE 	SCALE 	PLOT
		SHEET 1	OF 6

**INSTALLATION
OPERATIONS AND
MAINTENANCE
MANUAL**



**AIRE-O₂[®]
HORIZONTAL
AERATOR**

10 - 30 HP

**INSTALLATION
OPERATION
AND
MAINTENANCE
MANUAL**

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AIRE-O₂[®] Aeration systems, specifications, and instructions in this manual are subject to revision without prior notice or incurring obligation.

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4100 Peavey Road, Chaska, Minnesota 55318 USA

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Facsimile: 952.448.7293
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1.0 INTRODUCTION 2

1.1 THE COMPANY 2

1.2 HOW THE AIRE-O₂® AERATOR WORKS 2

2.0 SAFETY 3

2.1 NOTATION CONVENTIONS 3

2.2 YOUR ORGANIZATION'S RESPONSIBILITY 3

2.3 SAFETY PRECAUTIONS 3

2.4 CAUTION INDICATORS 5

2.5 LOCKOUT TAGS 5

3.0 ASSEMBLY- NEW INSTALLATION 6

3.1 ASSEMBLY OVERVIEW 6

3.2 FLOAT ASSEMBLY 7

3.2.1 FLOAT DIMENSIONAL DRAWINGS 8

3.2.2 3 & 4 FLOAT AND FRAME ASSEMBLY DRAWINGS 10

3.3 AIRE-O₂® AERATOR ASSEMBLY 15

3.3.1 AIRE-O₂® AERATOR ASSEMBLY DRAWINGS 16

3.4 VORTEX SHIELD ASSEMBLY 29

3.5 AIRE-O₂® AERATOR ASSEMBLY PLACEMENT 30

4.0 MOORING OPTIONS 31

4.1 FLOTATION CABLE ATTACHMENT 32

4.2 CABLE SAG ALLOWANCE 32

4.3 SPAN DIRECT MOORING 33

4.4 IN-LINE SPAN MOORING 34

4.4.1 TRI-FLOAT IN-LINE SPAN MOORING 34

4.4.2 FOUR FLOAT IN-LINE SPAN MOORING 35

4.4.3 SPAN BRIDLE ANGLED ASSEMBLY 36

4.4.4 SPAN BRIDLE MOUNTING 3&4 FLOAT 37

4.4.5 FLOAT SUPPORT ASSEMBLY 38

4.4.6 WALL MOUNT ASSEMBLY 10-30 HP GALV. & S.S. 39

4.4.7 WALL MOUNT VORTEX SHIELD ASSEMBLY 40

4.4.8 BRIDGE MOUNT ASSEMBLY GALV. & S.S. 42

4.4.9 VORTEX SHIELD BRIDGE MOUNT ASSEMBLY GALV. & S.S. 43

4.4.10 BRIDGE/WALL MOUNT CRANE 44

5.0 STARTUP 45

5.1 ELECTRICAL CHECK 45

5.2 MOTOR INTERNAL CONNECTIONS 46

5.3 START-UP PROCEDURE 46

5.4 ROTATION CHECK 46

5.5 FUNCTIONAL ELECTRICAL CHECK 47

5.6 OPERATIONAL CHECK 47

5.7 START-UP NOTES 48

5.8 MOTOR WARRANTY VALIDATION 50

6.0 MAINTENANCE 51

6.1 PREVENTIVE MAINTENANCE 51

6.2 MAINTENANCE AND SERVICE RECORD 52

6.3 MAINTENANCE AND SERVICE NOTES 53

7.0 AIRE-O₂® AERATOR SERVICE PROCEDURES 54

7.1 AIRE-O₂® AERATOR SERVICE 54

7.2 INSPECT THE AIRE-O₂® AERATOR 54

7.3 LUBRICATION 56

8.0 PROBLEM ANALYSIS 57

8.1 PROBLEM ANALYSIS OVERVIEW 57

8.2 PROBLEM ANALYSIS CHARTS 58

9.0 ELECTRICAL ASSEMBLY 62

9.1 THREE PHASE MOTOR CONNECTIONS 62

10.0 POWER CABLE SELECTION 67

10.1 POWER CABLE SIZE/LENGTH SELECTION OVERVIEW 67

10.2 CABLE SELECTION BY VOLTAGE CHARTS 68

11.0 PARTS ORDERING 74

11.1 PARTS NOTES 74

11.2 PARTS ORDER FORM 75

12.0 STORAGE PROCEDURES 76

13.0 WARRANTY 79

13.1 WARRANTY COVERAGE 79

13.2 RETURN-AUTHORIZATION 79

13.3 CREDITING / DEBITING YOUR ACCOUNT 79

14.0 SERVICE ADDENDUM 80

14.1 AIRE-O₂® AERATOR DISASSEMBLY AND REASSEMBLY 80

1.0 INTRODUCTION

IMPORTANT: Read all notations in bold print that appear throughout this manual. They are critical to the operation and maintenance of your AIRE-O₂[®] AERATOR System.

This manual is prepared to support the installation of an AIRE-O₂[®] AERATOR. The installation will provide improved performance through:

- Enhanced horizontal mixing
- High oxygen transfer
- Ease of installation
- Ease of maintenance
- Energy efficiency
- Winter treatment performance

Manual contents will help ensure obtaining these benefits. Please review the manual before proceeding. It will provide help for any problem that might arise.

NOTE: If further assistance is required, contact our Corporate Headquarters in Minneapolis, Minnesota U.S.A. Use our customer service Hot-Line number 1-800-328-8287.

1.1 THE COMPANY

Aeration Industries International, Inc., is recognized worldwide for treating domestic and industrial wastewater, for restoration of lakes, rivers, and harbors, in aquaculture, as well as in decorative ponds and golf courses. The company was established in 1974.

Customer service, combined with an aggressive program of research and development, has positioned the company as an innovator, concerned constantly with improving its product to contribute to cleaning the world's scarcest natural resource **water.**

The Research and Development Center, the heart of the company's 80,000 square foot world headquarters in Minneapolis, Minnesota, gives Aeration Industries International a world class facility to carry out its commitment to research and development in meeting the needs of its customers.

Aeration Industries International is the acknowledged worldwide leader in the resourceful application of innovative technology and expertise for the improvement of water quality. Aeration Industries International, Inc., has assumed a leadership position in solving diverse water quality problems worldwide. The company, working hand in hand with its customers, will ensure a brighter future by improving the environment around us.

1.2 HOW THE AIRE-O₂[®] AERATOR WORKS

The very small air bubbles produced by the AIRE-O₂[®] AERATOR fulfill the U.S.A. EPA requirements for fine bubbles. The propeller is designed specifically for each AIRE-O₂[®] AERATOR motor horse power. The propeller maximizes aeration and mixing while minimizing vortexing and cavitation. The water-lubricated lower bearing requires no other lubrication. Water is pulled into the bearing surface through holes adjacent to the bearing. The air is pulled down the drive hollow drive shaft and housing, where it is mixed with the water.

2.1 NOTATION CONVENTIONS

Throughout this manual important information will be emphasized for your protection or to protect the integrity of the AIRE-O₂[®] AERATOR.

“DANGER:” Indicates an imminently hazardous situation which, if not avoided, could result in death or serious injury.

“WARNING:” Indicates an imminently hazardous situation which, if not avoided, could result in death or serious injury.





“CAUTION:” indicates a potentially hazardous situation which, if not avoided, may result in injury. It may also be used to alert against unsafe practices.

“NOTE:” Is used to emphasize information crucial to protecting the machine. Personal safety is not the primary concern when a note is used to focus attention on a point.

2.2 YOUR ORGANIZATION’S RESPONSIBILITIES

Your organization has the responsibility for maintaining a safe work environment and must take responsibility for unique environmental situations where the AIRE-O₂[®] AERATOR will be installed including, electrical, mechanical, biological, **all in accordance with OSHA, Local, State and Federal Regulations.**

2.3 SAFETY PRECAUTIONS

	<p>! WARNING</p> <p>Moving parts can crush and cut</p> <p>Lock out power before servicing.</p>		<p>! DANGER</p> <p>HIGH VOLTAGE</p> <p>Lock out power before servicing.</p>
	<p>! WARNING</p> <p>ELECTRIC SHOCK HAZARD.</p> <p>This equipment is to be serviced by trained personnel only.</p>		<p>! WARNING</p> <p>Hoisted Items Can Crush Fingers.</p>

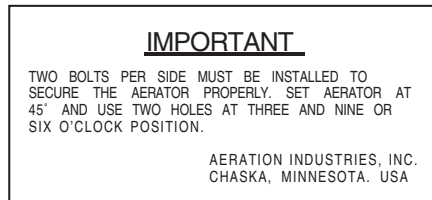
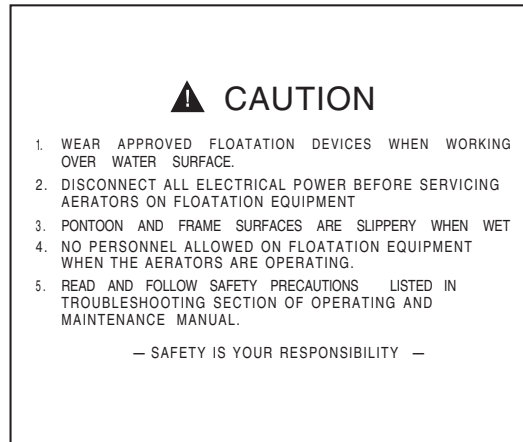
2.3 SAFETY PRECAUTIONS

Review the safety practices listed below. Questions should be resolved before proceeding.

1. Allow only qualified and authorized people to work on electrical equipment. A safety hazard of great concern is the possible activation of the AIRE-O₂[®] AERATOR during servicing. Disconnect power at the main power control panel. Be sure to use a lock out tag.
2. Unless a wire is positively known to be dead, treat it as a live wire.
3. Portable electrical tools should be grounded with a three conductor cord.
4. Do not lift objects too heavy for specific capabilities. Get help or use a hoist or crane.
5. Do not exceed the lifting capacity of a crane or hoist.
6. Designate one person to direct the crane operator.
7. Wear a hard hat when using lifting equipment.
8. Do not stand under any lifting object.
9. To prevent falls, recognize that flotation surfaces may be slippery when wet.
10. Clean up any spills in the work area.
11. Wear a life preserver in area's such as the edges of tanks or when working over water.
12. Never place hands or tools in the air intake holes or near the propeller when the unit is running or not locked "out of service."
13. As the treated liquid may be a source of infection, the best defense against infection is the practice of good personal hygiene and prompt medical attention for any injury that breaks the skin.
14. Workers should keep their fingers out of the eyes, nose, and mouth.
15. Never smoke or eat while working around waste water.
16. Wear gloves when handling the AIRE-O₂[®] AERATOR propeller to protect yourself from sharp edges.

2.4 CAUTION INDICATORS

When one is working near an AIRE-O₂[®] AERATOR, you will notice bright yellow decals to remind you of safe practices. Samples are shown below;



2.5 LOCKOUT TAGS

A safety hazard of great concern is the possible activation of the AIRE-O₂[®] AERATOR when you are servicing it. A minimum precaution is to use “lockout” cards on switching equipment controlling the AIRE-O₂[®] AERATOR. The best precaution is to lockout the equipment with some form of key lock.

An example of a “lockout” card is shown. They may be purchased from sign supply houses. When an AIRE-O₂[®] AERATOR is shut off for service, the card is hung or fastened on the switch or controller to inform others not to operate the switch. In addition, locking the switch off should be done if possible.



3.0 ASSEMBLY - NEW INSTALLATION

3.1 ASSEMBLY OVERVIEW

New Installation

This section will guide initial assembly of components as received from the factory. After removing them from their shipping container, examine components for any shipping damage.

Assembly Overview

First, assemble the flotation assembly (see pages 8 - 13). Next, mount the AIRE-O₂[®] AERATOR to the flotation assembly (see pages 16 - 29). Flotation assemblies must then be positioned in the water and the motor electrical cable attached.

NOTE: Electric wiring cable, clamps, ties and related electrical supplies are to be provided by the customer unless specifically ordered with the AIRE-O₂[®] AERATOR.

3.2 FLOAT ASSEMBLY

Note: Important!!! Select a level work area. Do not tighten any fasteners until unit is completely assembled and lined up.

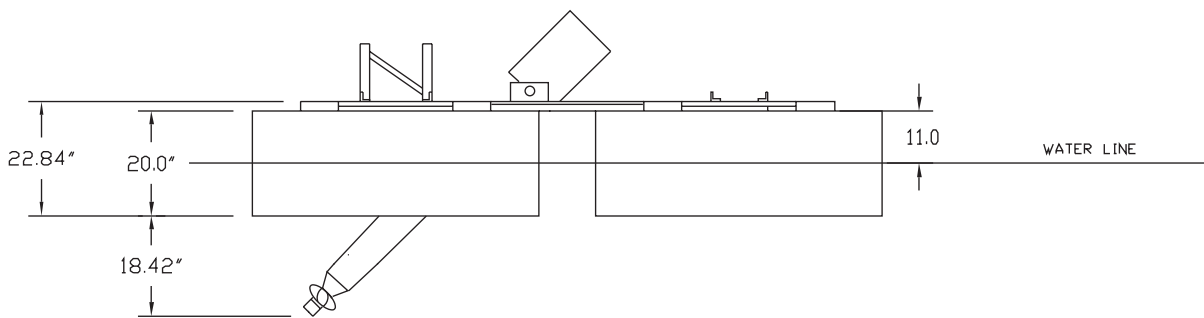
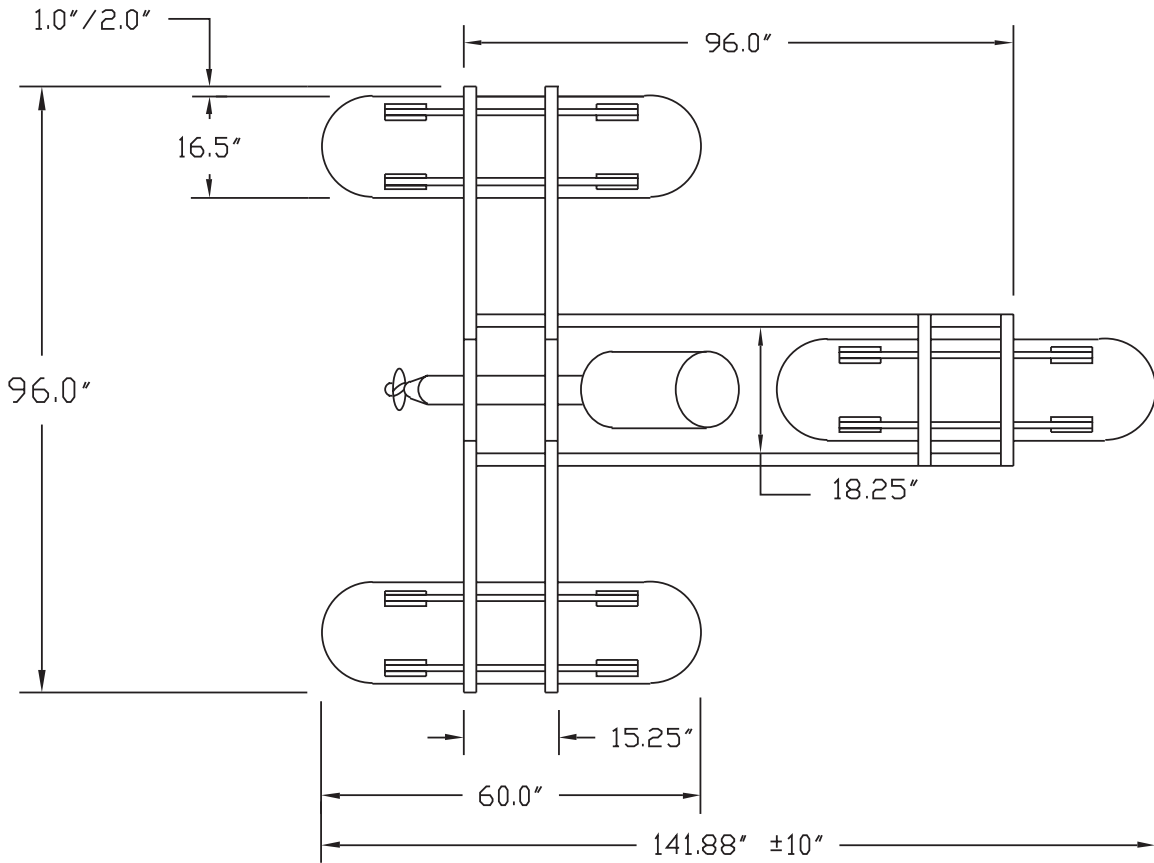
1. Place each float on the ground, spacing them approximately as shown in the dimensional drawings (pages 8-9).
2. Using assembly drawings (pages 10-13), assemble the cross-arches, cross rails, and main frame on the pontoons as shown.
3. Place the U-bolts in position on each pontoon. See assembly drawings for location (pages 10-13).
4. Attach cross rails & arches loosely to main frame. It may be necessary to enlist the assistance of additional personnel.
5. The mount bracket should be positioned on main frame using the lower two sets of holes. See assembly drawings (pages 10-13) for reference.
6. As indicated in the assembly drawings (pages 10-13), remove and replace the bolt from each front pontoon with the eyebolts provided. Eye is toward the inside of the pontoon.
Note: Reuse washers and nut from bolt. These eyebolts will be used to attach vortex shield at final assembly.

Note: Be sure to square the frame before tightening the fasteners. This can be verified by measuring corner to corner at identical reference points on the frame.

7. After unit is completely assembled and squared, tighten all fasteners.

3.2.1 FLOAT DIMENSIONAL DRAWINGS

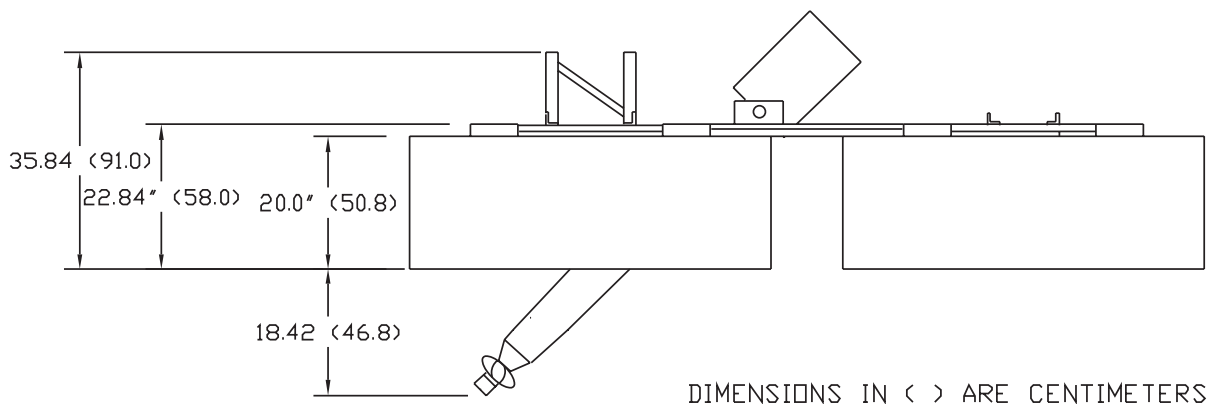
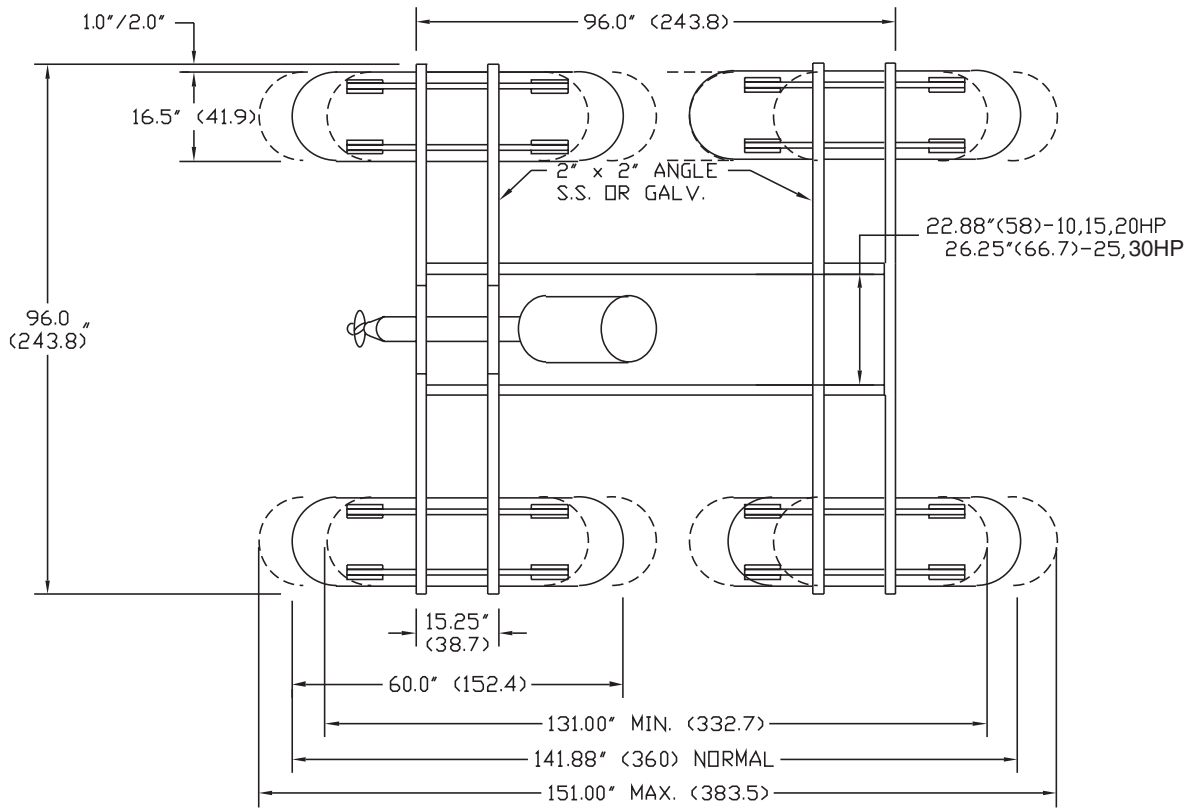
Three Float Dimensional Drawings



*Used with 10 - 20 HP NEMA & I.E.C.
25 - 30 HP 60Hz NEMA

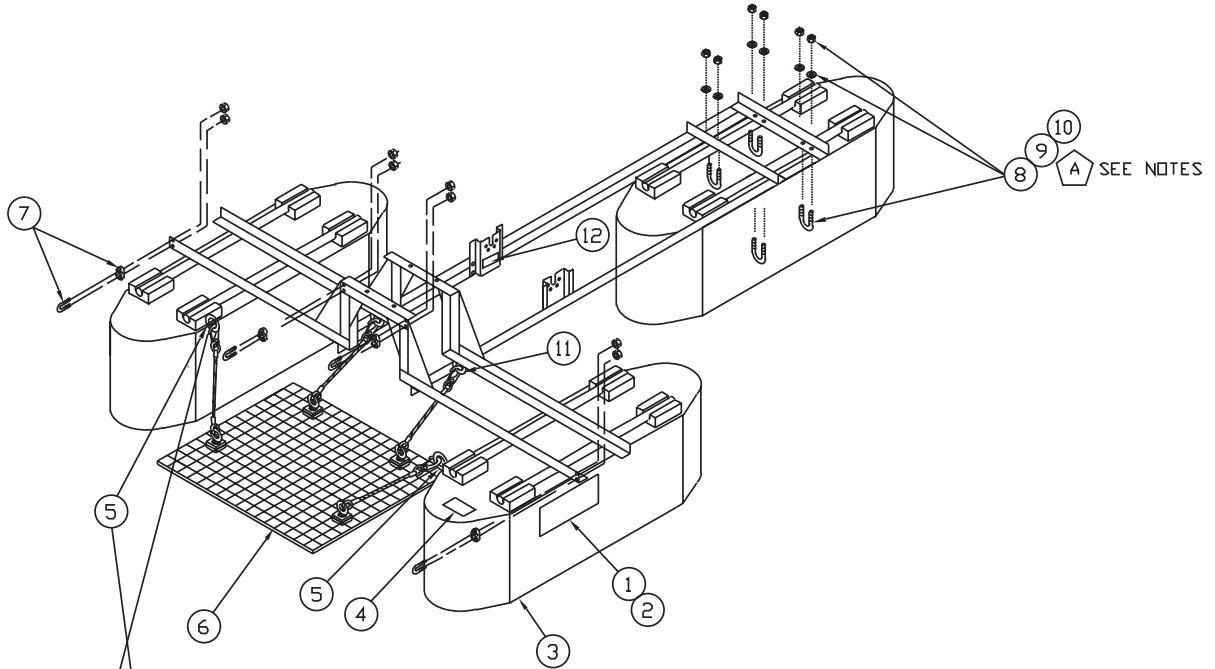
SK93-066

Four Float Dimensional Drawings



*Used with 25 -30 HP (50Hz) NEMA & I.E.C.

Tri-Float Assembly Drawings Galvanized and Stainless Steel 60-50 HZ IEC

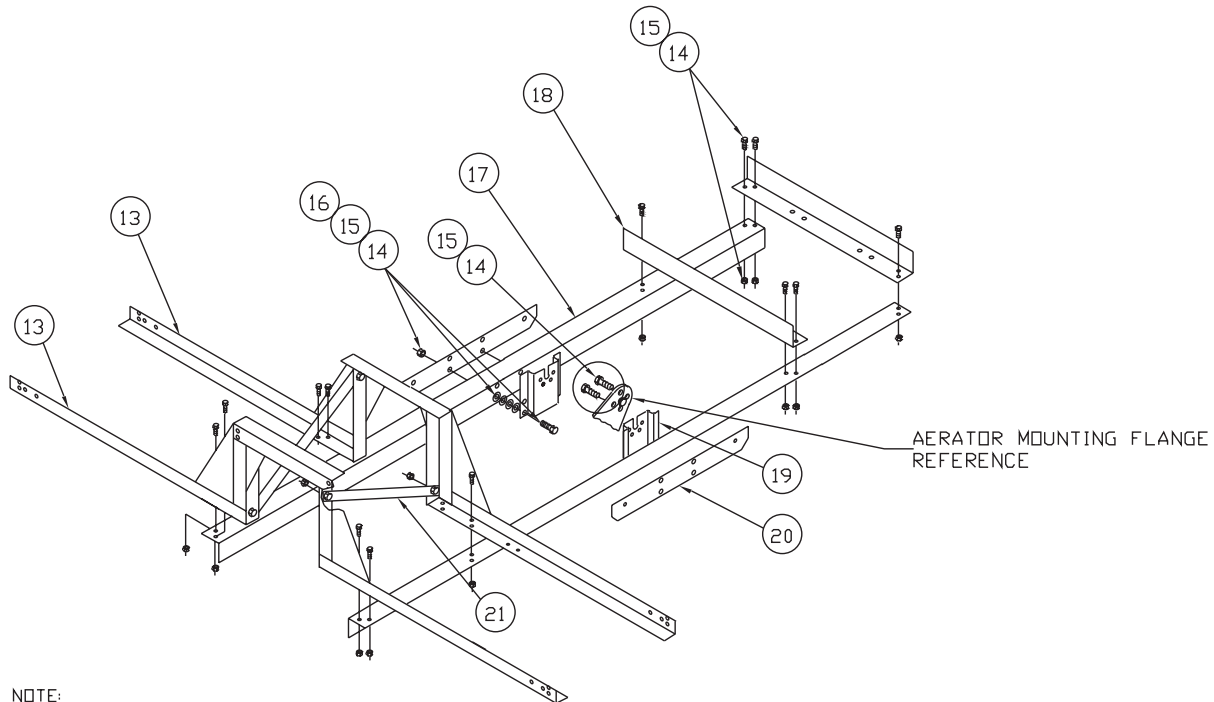


NOTE:
 * 1. WHEN ORDERING REPLACEMENT PARTS SPECIFY EITHER STAINLESS STEEL OR GALVANIZED.
 A 2. NEEDED WHEN STAINLESS STEEL U-BOLTS ARE USED.

TRI-FLOAT HARDWARE (GALV. & SS)

ITEM #	PART #	DESCRIPTION	QTY.
1	224-112	LABEL, PHONE# DOMESTIC	2
2	224-113	LABEL, PHONE# INTERNATIONAL	2
*3	336-005	PONTOON ASS'Y S.S.	3
	336-001	PONTOON ASS'Y GALV	3
4	224-019	LABEL, FLOATATION SAFTEY	1
*5	215-209	EYEBOLT 3/8" x 4 1/2" PLATED	2
	215-207	EYEBOLT 3/8" x 4 1/2" S.S.	2
6	410-614	VORTEX SHIELD ASS'Y	1
*7	221-019	WIRE ROPE CLAMP ASS'Y 3/8" GALV	4
	221-022	WIRE ROPE CLAMP ASS'Y 3/8" S.S.	4
*8	215-184	U-BOLT S.S	12
	215-022	U-BOLT W/NUTS 5/16-18 GALV.	12
A 9	215-052	HEX NUT 5/16-18 S.S.	32
10	215-027	5/16 LOCKWASHERS.	32
*11	215-206	EYEBOLT 3/8" x 1 1/4" SS	2
	215-133	EYEBOLT 3/8" x 1 1/4" GALV	2
12	224-017	LABEL, MOUNT BRACKET	1

Tri-Float Galvanized and Stainless Steel Frame Assembly Drawings



NOTE:

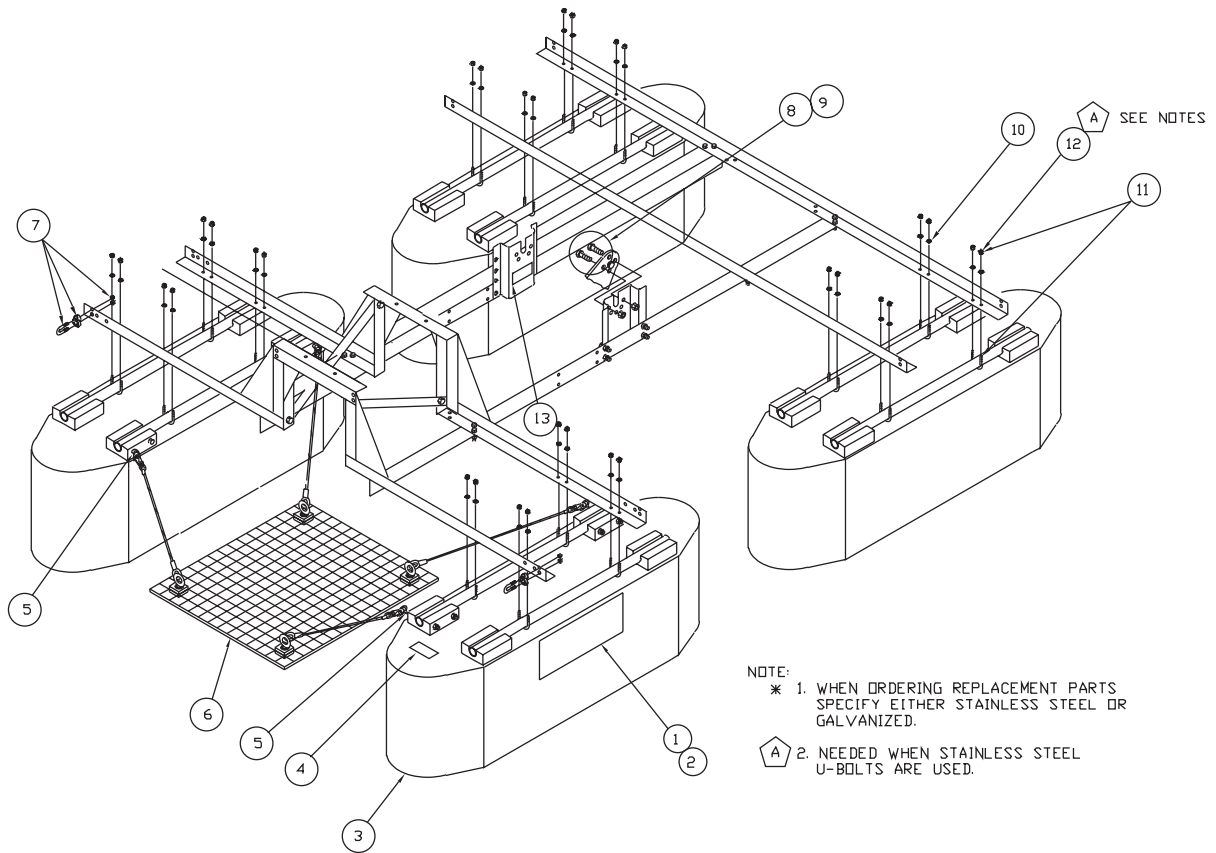
- * 1. WHEN ORDERING REPLACEMENT PARTS SPECIFY EITHER STAINLESS STEEL OR GALVANIZED.

TRI-FLOAT FRAME HARDWARE (GALV. & SS)

ITEM #	PART #	DESCRIPTION	QTY.
13	214-393	CROSS ARCH S.S.	2
	214-059	CROSS ARCH GALV	2
14	215-032	CAPSCREW 3/8-16 x 1 1/4" SS	30
	215-081	LOCKNUT 3/8-16	30
16	215-104	FLATWASHER 3/8 (S.S. ASSY. ONLY)	16
17	214-062	MAINFRAME S.S.	2
	214-844	MAINFRAME GALV	2
18	214-965	REAR CROSSRAIL S.S.	2
	214-966	REAR CROSSRAIL GALV.	2
19	214-061	MOUNT BRACKET S.S.	2
	214-014	MOUNT BRACKET GALV.	2
20	214-064	BRACKET SUPPORT (S.S. ASSY ONLY)	2
	214-874	GUSSET S.S.	2
21	214-873	GUSSET GALV.	2



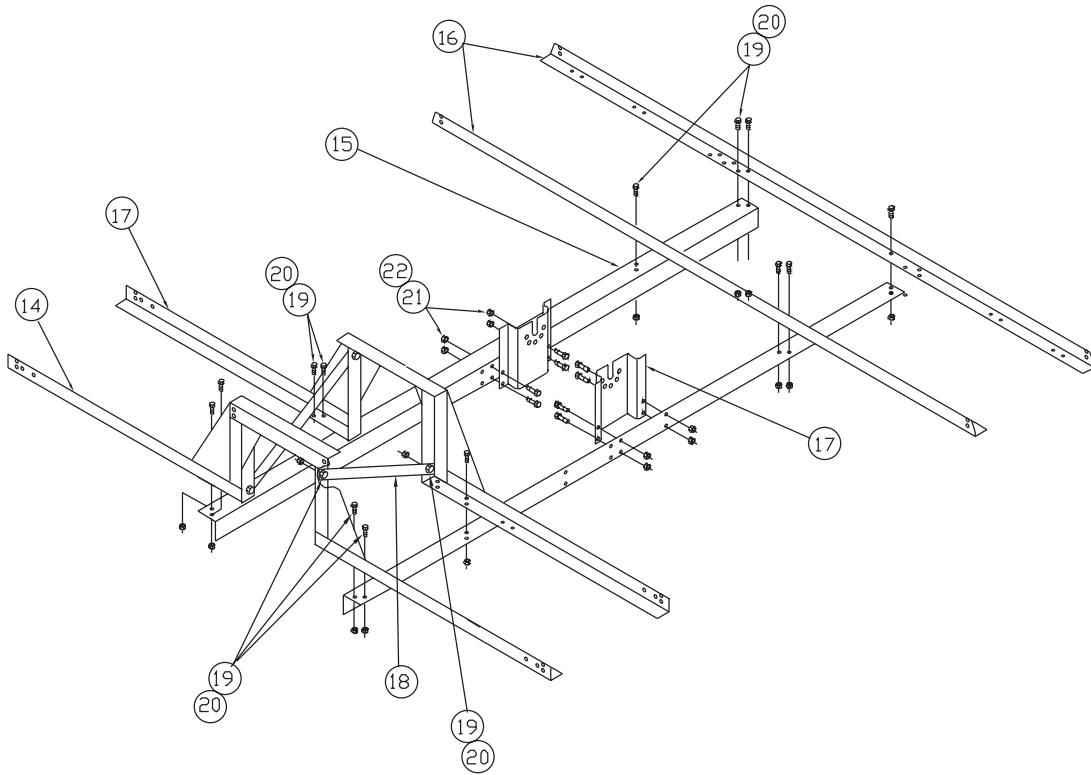
Four Float Assembly Drawings Galvanized and Stainless Steel 60-50 HZ IEC



FOUR FLOAT HARDWARE (GALV. & SS)

ITEM #	PART #	DESCRIPTION	QTY.
1	224-112	LABEL, PHONE# DOMESTIC	2
2	224-113	LABEL, PHONE# INTERNATIONAL	2
*3	336-005	PONTOON ASS'Y S.S.	4
	336-001	PONTOON ASS'Y GALV	4
4	224-019	LABEL, FLOATATION SAFTEY	1
*5	215-209	EYEBOLT 3/8" x 4 1/2" PLATED	4
	215-207	EYEBOLT 3/8" x 4 1/2" S.S.	4
6	410-591	VORTEX SHIELD ASS'Y	1
*7	221-019	WIRE ROPE CLAMP ASS'Y 3/8" GALV	4
	221-022	WIRE ROPE CLAMP ASS'Y 3/8" S.S.	4
*8	215-197	CAPSCREW 3/4-10 x 2 1/2 SS 20/25HP	4
	215-099	CAPSCREW 1/2-13 x 1 1/2 SS 10-15HP	4
*9	215-198	LOCKNUT 3/4-10 SS 20-25HP	4
	215-093	LOCKNUT 1/2-13 SS 10-15HP	4
10	215-027	5/16 LOCKWASHERS	32
*11	215-184	U-BOLT 5/16-18 S.S.	16
	215-022	U-BOLT W/NUTS 5/16-18 GALV.	16
A 12	215-052	HEX NUT 5/16-18 S.S.	32
13	224-017	LABEL, MOUNT BRACKET	1

**Four Float Frame Assembly Drawings
Galvanized and Stainless Steel 60-50 HZ IEC**



NOTE:
* 1. WHEN ORDERING REPLACEMENT PARTS
SPECIFY EITHER STAINLESS STEEL OR
GALVANIZED.

FOUR FLOAT FRAME HARDWARE (GALV. & SS)

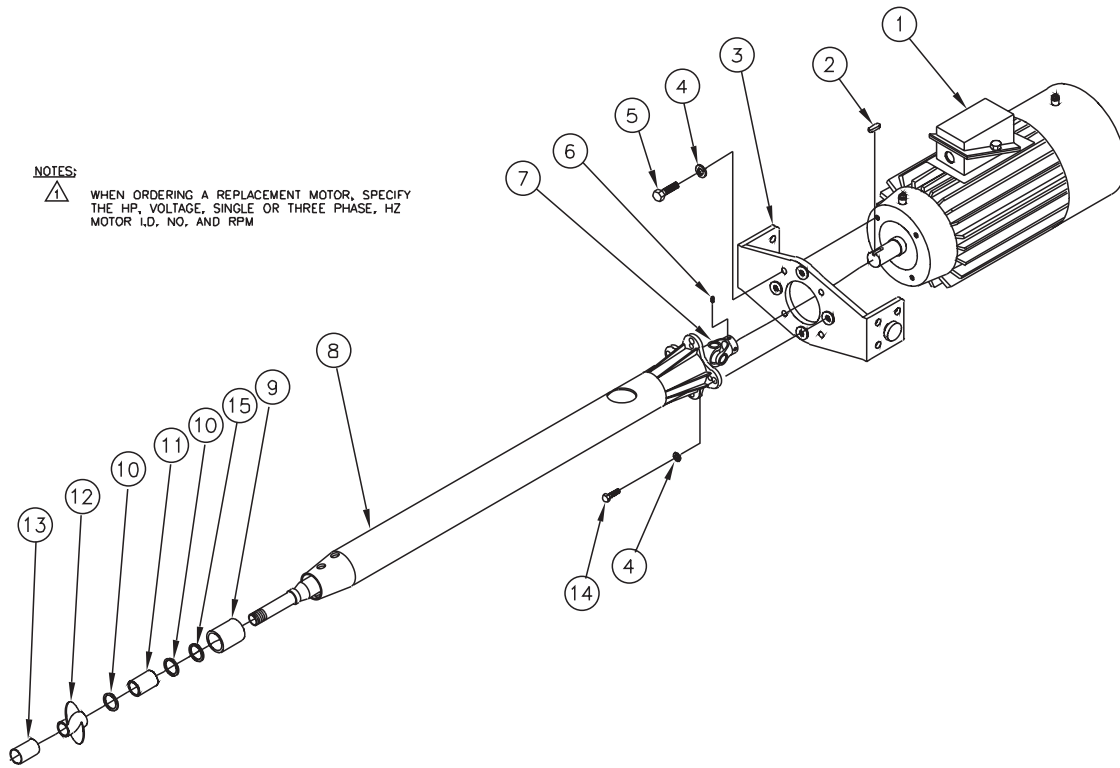
ITEM #	PART #	DESCRIPTION	QTY.
*14	214-393	CROSS ARCH S.S.	2
	214-385	CROSS ARCH GALV	2
*15	214-845	MAINFRAME S.S.	2
	214-844	MAINFRAME GALV	2
*16	214-421	REAR CROSSRAIL S.S.	2
	214-440	REAR CROSSRAIL GALV.	2
*17	214-061	MOUNT BRACKET S.S. 10-15 HP	2
	214-807	MOUNT BRACKET S.S. 20-25HP	2
	214-014	MOUNT BRACKET GALV. 10-15HP	2
	214-812	MOUNT BRACKET GALV. 20/25/30HP	2
*18	214-874	GUSSET S.S.	2
	214-873	GUSSET GALV.	2
19	215-032	CAPSCREW 3/8-16 x 1 1/4" SS	20
20	215-081	LOCKNUT 3/8-16 SS	20
21	215-099	CAPSCREW .50-13UNC x 1.50 SS 20-25HP	8
	215-032	CAPSCREW .375-16UNC x 125 SS 10-15HP	8
22	215-093	LOCKNUT .50-13UNC SS 20-25HP	8
	215-081	LOCKNUT .375-16UNC SS 10-15HP	8

3.3 AIRE-O₂[®] AERATOR ASSEMBLY

1. Lift the AIRE-O₂[®] AERATOR assembly using a hoist and sling. Maneuver the AIRE-O₂[®] AERATOR housing between the main frames of the float assembly with the propeller toward the front and under the crossrail weldments. Position the motor mounting pins above the slots in the mount brackets. Gently lower the unit to rest in the bottom of the slots.
2. Lower the hoist to allow the sling to become loose. Pivot the AIRE-O₂[®] AERATOR to a horizontal position. Secure with bolts through the mount bracket and motor mounting flange. Now, remove the sling entirely once the motor is bolted in place.

3.3.1 AIRE-O₂[®] AERATOR ASSEMBLY DRAWINGS

10 HP, 60HZ, 2 POLE, NEMA



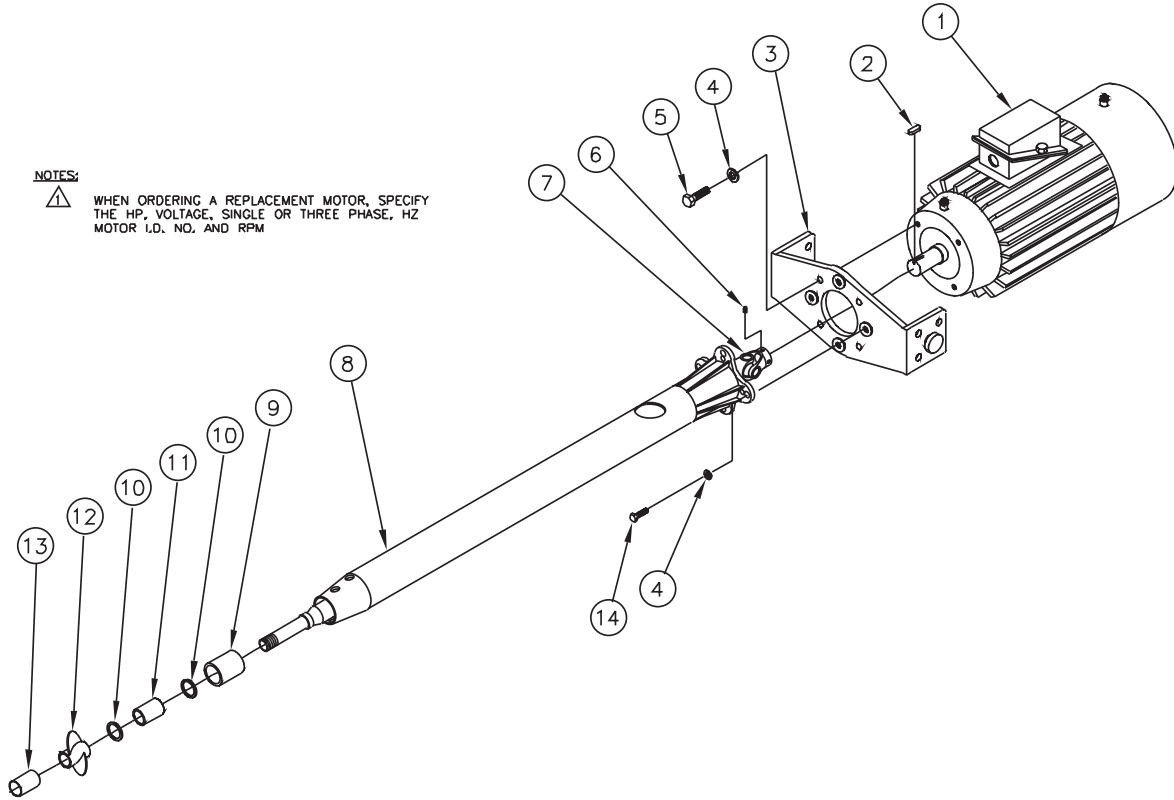
NOTES:
 ⚠ WHEN ORDERING A REPLACEMENT MOTOR, SPECIFY THE HP, VOLTAGE, SINGLE OR THREE PHASE, HZ MOTOR I.D. NO. AND RPM

AERATOR HARDWARE

ITEM #	PART #	DESCRIPTION	QTY.
⚠ 1	-----	MOTOR	1
2	215-098	MOTOR KEY	1
3	330-028	MOUNTING FLANGE, 10 - 20HP	1
4	215-100	LOCK WASHER, .50	8
5	215-147	CAPSCREW .50-13UNC X 1.25	4
6	215-127	SETSCREW .375-16UNC	2
7	239-070	SHAFT, 10 20HP STANDARD	1
8	330-086	HOUSING, 10 - 20HP	1
9	213-052	BEARING, 10HP ABRASIVE RESISTANT	1
	213-025	BEARING, 10HP CHEMICAL RESISTANT	1
10	215-121	NYLON WASHER, 10HP	2
11	247-041	SLEEVE, 10HP	1
12	234-066	PROPELLER, 10HP,60HZ, 2 POLE	1
13	223-027	DIFFUSER, 10HP	1
14	215-088	CAPSCREW .50-13UNC X 1.00	4
15	215-200	SPACER,10HP	1

3.3.1 AIRE-O₂® AERATOR ASSEMBLY DRAWINGS

15 - 20 HP, 60HZ, 4 Pole NEMA



NOTES:



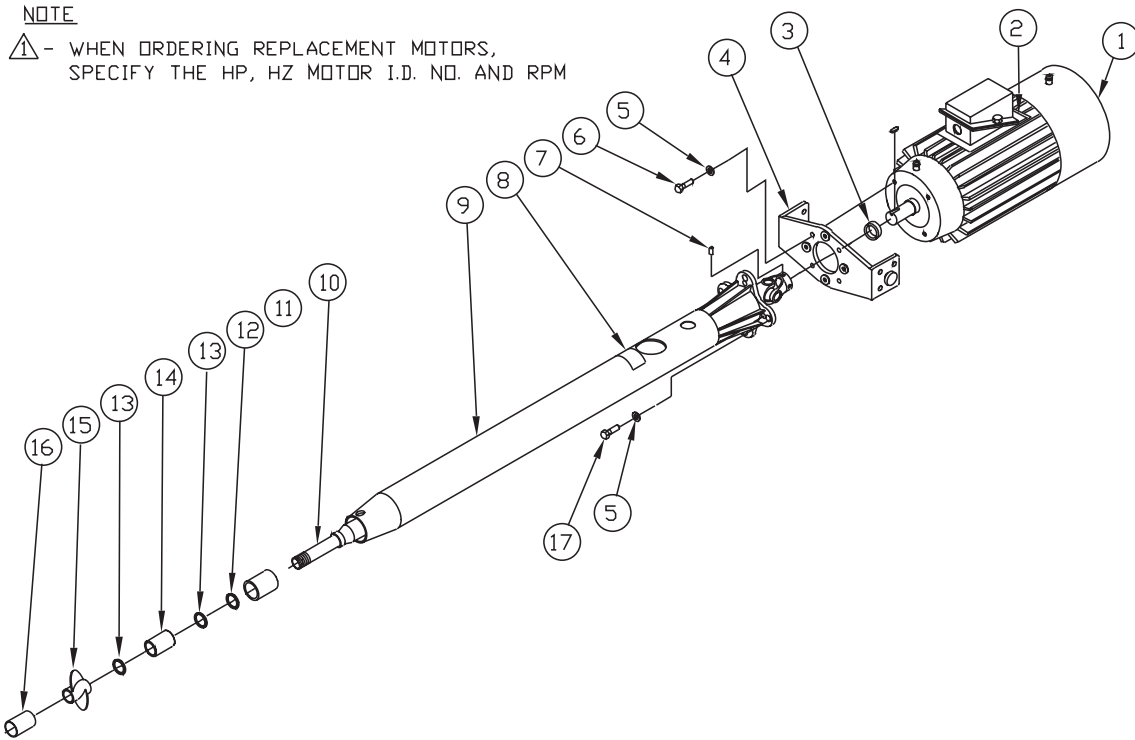
WHEN ORDERING A REPLACEMENT MOTOR, SPECIFY THE HP, VOLTAGE, SINGLE OR THREE PHASE, HZ MOTOR I.D. NO. AND RPM

AERATOR HARDWARE

ITEM #	PART #	DESCRIPTION	QTY.
△ 1	-----	MOTOR	1
2	215-098	MOTOR KEY	1
3	330-028	MOUNTING FLANGE, 15 - 20HP	1
4	215-100	LOCK WASHER, .50	8
5	215-147	CAPSCREW .50-13UNC X 1.25	4
6	215-127	SETSCREW .375-16UNC	2
7	239-061	SHAFT, 15 20HP STANDARD	1
8	330-086	HOUSING, 15 - 20HP	1
9	213-053	BEARING, 15 - 20HP ABRASIVE RESISTANT	1
	213-026	BEARING, 15 - 20HP CHEMICAL RESISTANT	1
10	215-123	NYLON WASHER, 15 -20HP	2
11	247-034	SLEEVE, 15-20HP	1
12	234-152	PROPELLER, 20HP, 60HZ, 2 POLE	1
	234-067	PROPELLER, 15HP, 60HZ, 2 POLE	1
13	223-028	DIFFUSER, 15 - 20HP	1
14	215-088	CAPSCREW .50-13UNC X 1.00	4

3.3.1 AIRE-O₂® AERATOR ASSEMBLY DRAWINGS

10 - 20HP, 60HZ, 4 - Pole, NEMA



AERATOR HARDWARE

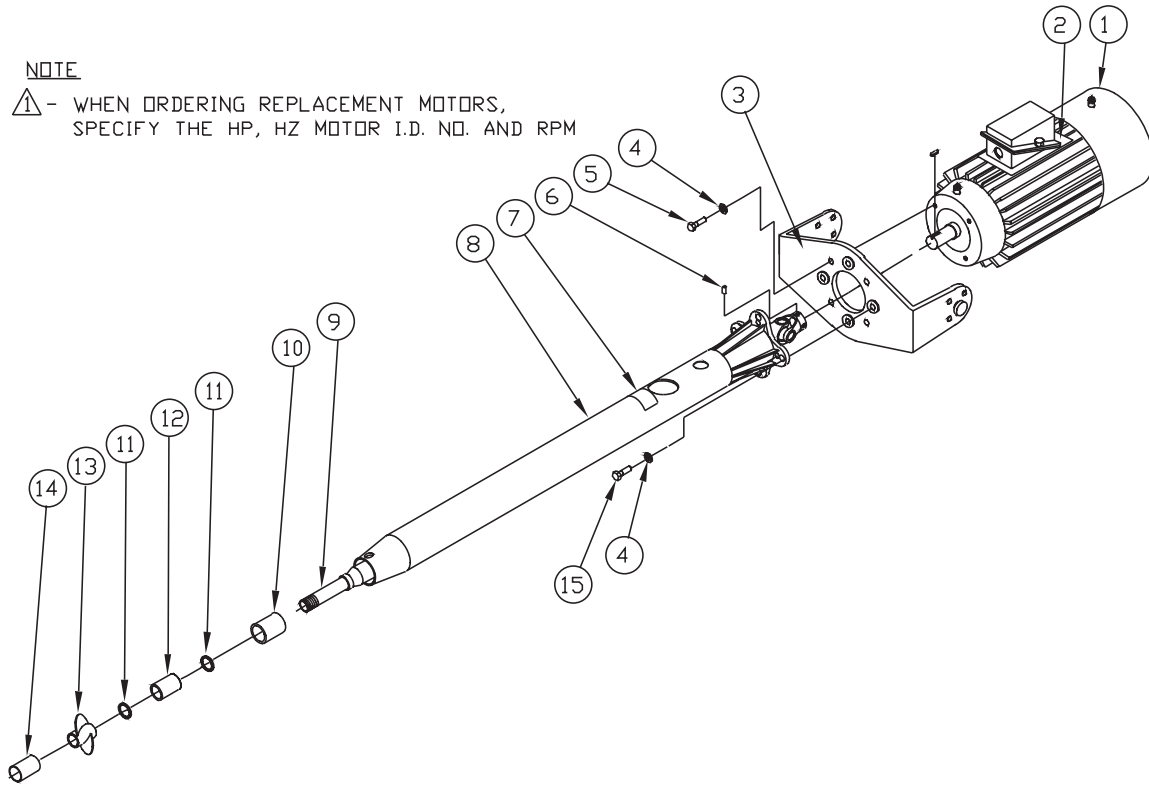
ITEM #	PART #	DESCRIPTION	QTY.
▲ 1	-----	MOTOR	1
2	224-013	DECAL SERIAL NO.	1
3	215-158	SPACER 15 & 20 HP ONLY	1
4	330-028	MOUNTING FLANGE	1
5	215-100	LOCKWASHER .50	8
5	215-147	CAPSCREW .50-13UNC X 1.25	4
7	215-127	SETSCREW .375-16UNC	2
8	224-021	LABEL, CAUTION	1
9	330-086	HOUSING	1
10	239-070	SHAFT ASSEMBLY	1
11	213-052	BEARING, 10 - 20HP ABRASION RESISTANT	1
	213-025	BEARING, 10 - 20HP CHEMICAL RESISTANT	1
12	215-200	WASHER, SS	1
13	215-121	WASHER, NYLON	2
14	247-041	SLEEVE	1
15	234-094	PROPELLER - 10HP	1
	234-243	PROPELLER - 15HP	1
	234-244	PROPELLER - 20HP	1
16	223-027	DIFFUSER	1
17	215-088	CAPSCREW .50-13UNC X 1.00	4

3.3.1 AIRE-O₂® AERATOR ASSEMBLY DRAWINGS

25 - 30HP, 60HZ, 4 Pole NEMA

NOTE

⚠ - WHEN ORDERING REPLACEMENT MOTORS, SPECIFY THE HP, HZ MOTOR I.D. NO. AND RPM

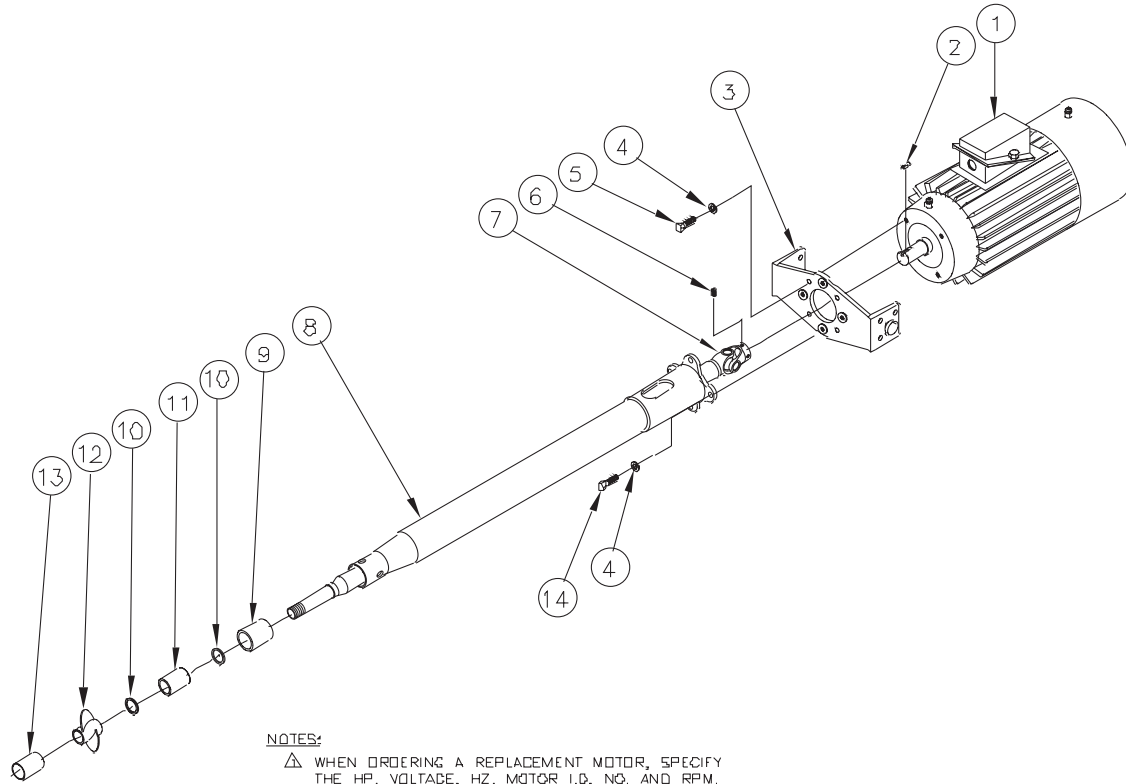


AERATOR HARDWARE

ITEM #	PART #	DESCRIPTION	QTY.
⚠ 1	-----	MOTOR	1
2	224-013	DECAL SERIAL NO.	1
3	245-030	MOUNTING FLANGE	1
4	215-100	LOCKWASHER .50	8
5	215-147	CAPSCREW .50-13UNC X 1.250	4
6	215-127	SETSCREW .375-16UNC	2
7	224-021	LABEL CAUTION	1
8	330-086	HOUSING	1
9	239-063	SHAFT ASSEMBLY	1
10	213-053	BEARING, 25 - 30HP ABRASION RESISTANT	1
	213-026	BEARING, 25 - 30HP CHEMICAL RESISTANT	1
11	215-123	WASHER, NYLON	2
12	247-034	SLEEVE	1
13	234-092	PROPELLER 25HP	1
	231-093	PROPELLER 30HP	1
14	223-028	DIFFUSER	1
15	215-088	CAPSCREW .50-13UNC X 1.00	4

3.3.1 MOTOR ASSEMBLY DRAWINGS

AIRE-O₂® AERATOR Assembly 10 - 20HP, 50HZ, 2 Pole NEMA



NOTES:

⚠ WHEN ORDERING A REPLACEMENT MOTOR, SPECIFY THE HP, VOLTAGE, HZ, MOTOR I.D. NO. AND RPM.

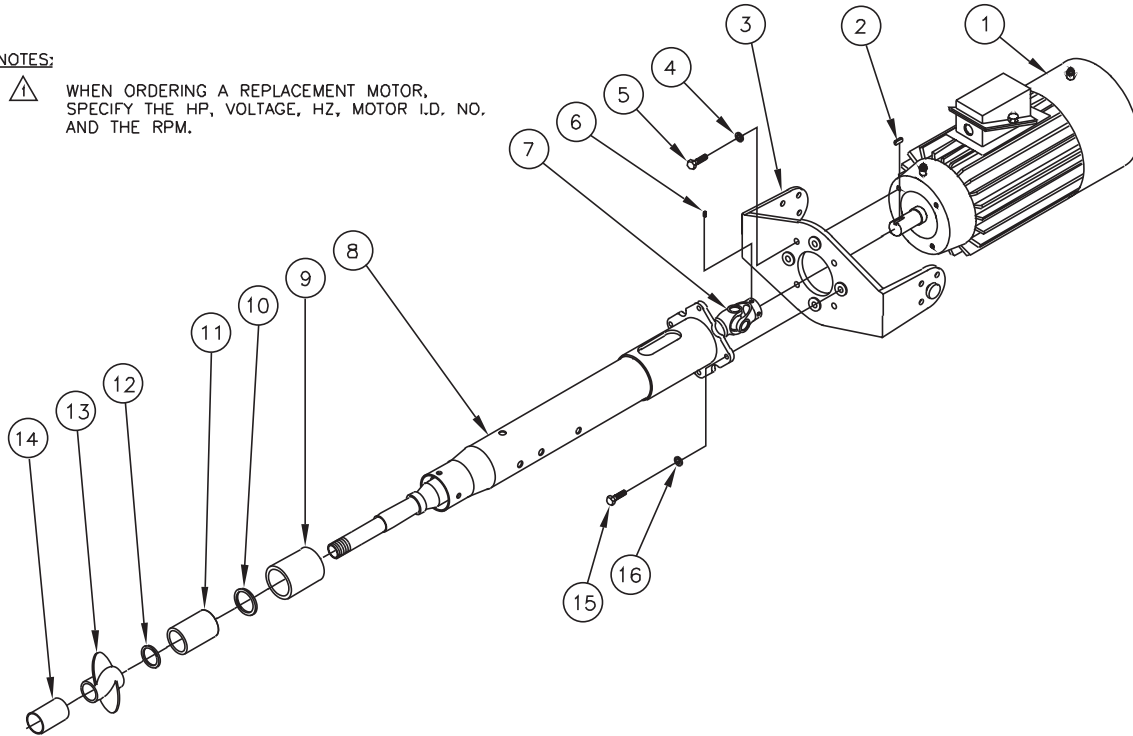
AERATOR HARDWARE

ITEM #	PART #	DESCRIPTION	QTY.
⚠ 1	-----	MOTOR	1
2	215-098	MOTOR KEY	1
3	330-028	MOUNTING FLANGE, 10 - 20HP	1
4	215-100	LOCK WASHER, .50	8
5	215-147	CAPSCREW .50-13UNC X 1.25	4
6	215-127	SETSCREW .375-16UNC	2
7	239-061	SHAFT, 10 20HP STANDARD	1
8	330-075	HOUSING, 10 - 20HP	1
9	213-026	BEARING, 10 - 20 CHEMICAL RESISTANT	1
	213-053	BEARING, 10 - 20HP ABRASIVE RESISTANT	1
10	215-123	NYLON WASHER, 10 -20HP	2
11	247-034	SLEEVE, 10-20HP	1
12	234-125	PROPELLER, 20HP, 50HZ	1
	234-106	PROPELLER, 15HP, 50HZ	1
	234-105	PROPELLER, 10HP, 50HZ	1
13	223-028	DIFFUSER, 10 - 20HP	1
14	215-088	CAPSCREW .50-13UNC X 1.00	4

25 - 30HP, 50HZ, 4 Pole NEMA

NOTES:

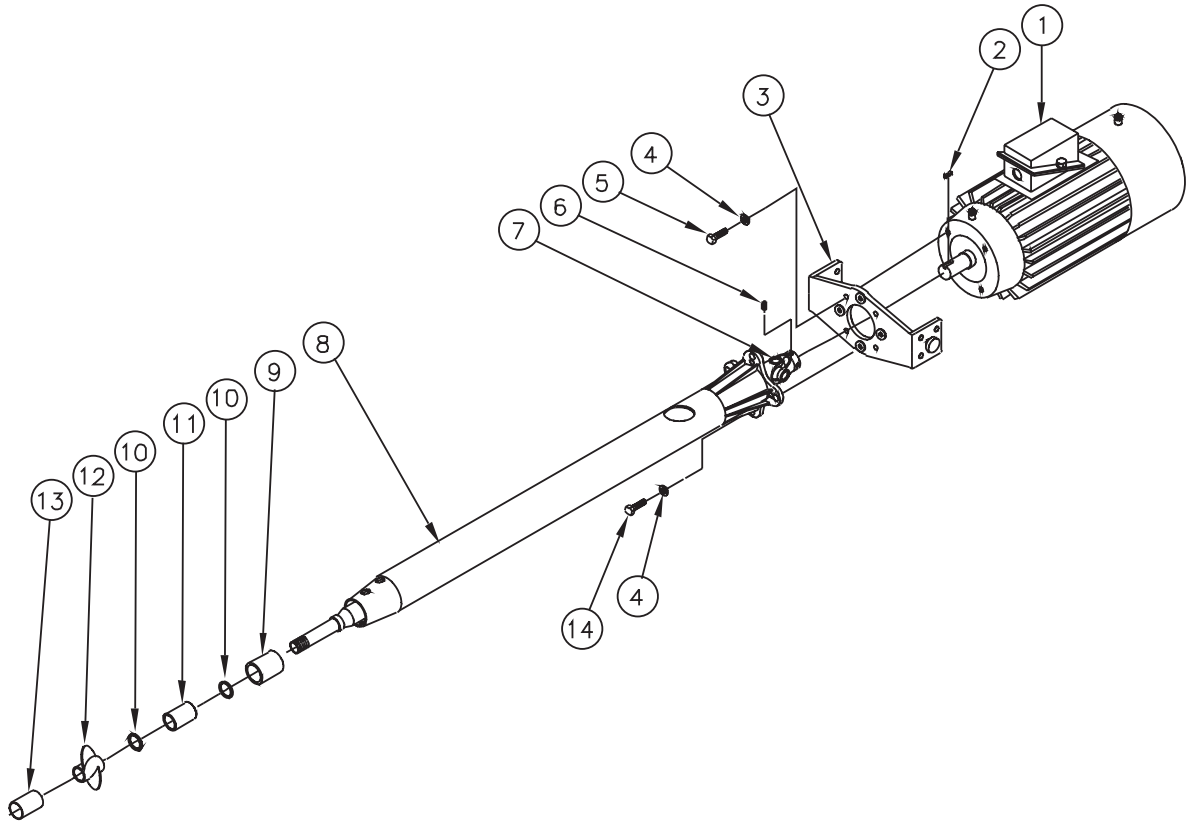
⚠ WHEN ORDERING A REPLACEMENT MOTOR, SPECIFY THE HP, VOLTAGE, HZ, MOTOR I.D. NO. AND THE RPM.



AERATOR HARDWARE

ITEM #	PART #	DESCRIPTION	QTY.
⚠ 1	-----	MOTOR	1
2	215-152	MOTOR KEY	1
3	245-043	MOUNTING FLANGE, 25 - 30HP	1
4	215-100	LOCK WASHER, .50	4
5	215-099	CAPSCREW .50-13UNC X 1.50	4
6	215-156	SETSCREW .50-13UNC	2
7	239-067	SHAFT, STANDARD 25 - 30HP	1
8	330-036	HOUSING, 25 - 30HP	1
9	213-054	BEARING, 25 - 30HP ABRASION RESISTANT.	1
	213-027	BEARING, 25 - 30HP CHEMICAL RESISTANT	1
10	215-149	NYLON WASHER, 3.25 I.D.	1
11	247-033	SLEEVE, 25 - 30HP	1
12	215-201	NYLON WASHER, 2.88 I.D.	1
13	234-126	PROPELLER, 30HP, 50HZ	1
	234-070	PROPELLER, 25HP, 50HZ	1
14	223-025	DIFFUSER	1
15	215-150	CAPSCREW .625-11UNC X 1.50	4
16	215-151	LOCKWASHER, .625	4

10 - 20HP 50HZ 4 Pole NEMA



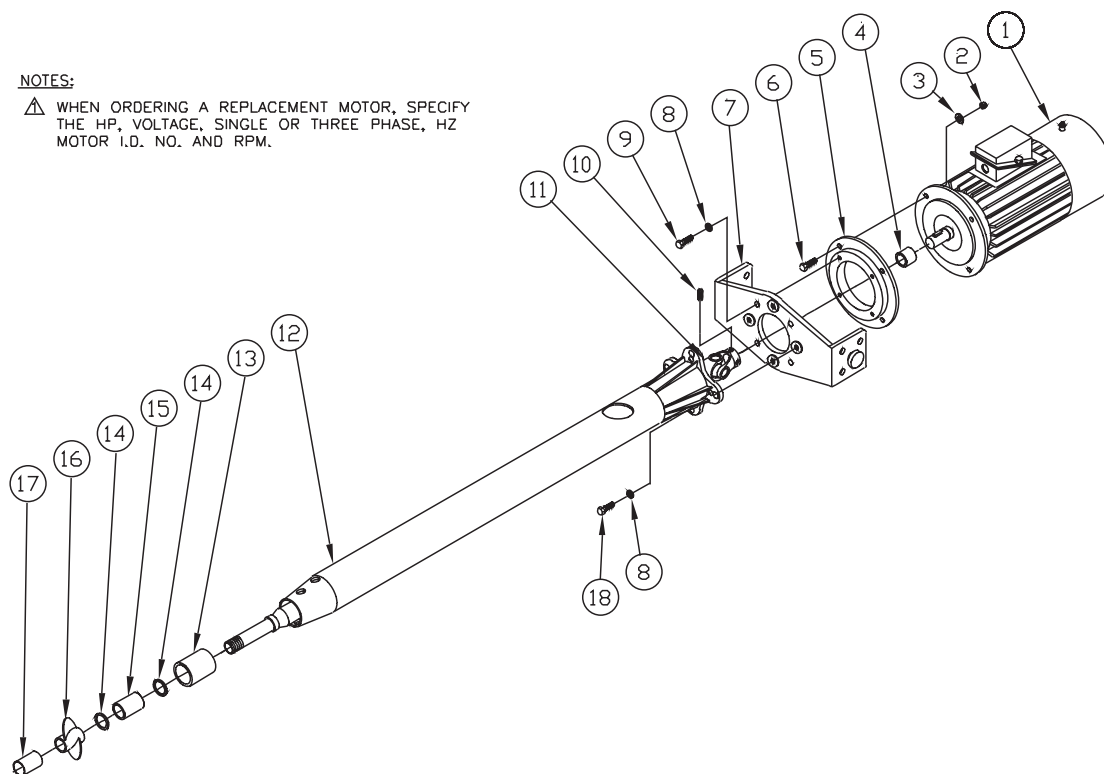
AERATOR HARDWARE

ITEM #	PART #	DESCRIPTION	QTY.
1	-----	MOTOR	1
2	215-098	MOTOR KEY	1
3	330-028	MOUNTING FLANGE, 10 - 20HP	1
4	215-100	LOCK WASHER, .50	8
5	215-147	CAPSCREW .50-13UNC X 1.25	4
6	215-127	SETSCREW .375-13UNC	2
7	239-148	SHAFT, 10 - 20HP ABRASIVE RESISTANT	1
	239-061	SHAFT, 10 - 20HP STANDARD	1
8	330-088	HOUSING, 10 - 20HP	1
9	213-026	BEARING, 10 - 20HP CHEMICAL RESISTANT	1
	213-053	BEARING, 10 - 20HP ABRASIVE RESISTANT	1
10	215-123	NYLON WASHER, 10 - 20HP.	2
11	247-034	SLEEVE, 10 - 20HP	1
12	234-280	PROPELLER, 20HP, 50HZ	1
	234-180	PROPELLER, 15HP, 50HZ	1
	234-179	PROPELLER, 10HP, 50HZ	1
13	223-028	DIFFUSER 10 - 20HP	1
14	215-088	CAPSCREW .50-11UNC X 1.00	4

(IEC) 10 HP (7.5KW) 50HZ, 2 Pole

NOTES:

△ WHEN ORDERING A REPLACEMENT MOTOR, SPECIFY THE HP, VOLTAGE, SINGLE OR THREE PHASE, HZ MOTOR I.D. NO. AND RPM.



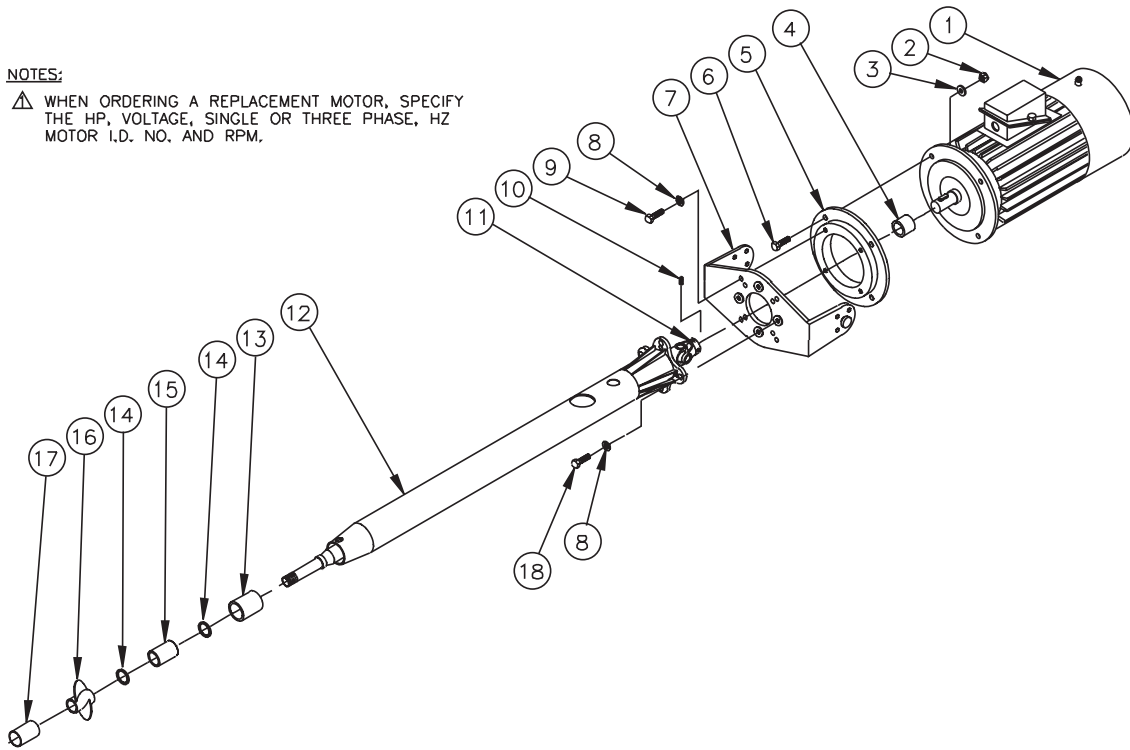
AERATOR HARDWARE

ITEM #	PART #	DESCRIPTION	QTY.
△ 1	-----	MOTOR (IEC) 10	1
2	215-093	LOCKNUT .50-13UNC	4
3	215-388	FLATWASHER .50 REDUCED O.D.	4
4	215-376	MOTOR SPACER	1
5	245-112	ADAPTER FLANGE	1
6	215-092	CAPSCREW .50-13UNC X 2.00	4
7	245-028	MOUNTING FLANGE	1
8	215-100	LOCKWASHER .50	8
9	215-147	CAPSCREW .50-13UNC X 1.25	4
10	215-127	SETScrew .375-16UNC	2
11	239-135	SHAFT	1
12	330-086	HOUSING	1
13	213-053	BEARING, ABRASION RESISTANT	1
	213-026	BEARING, CHEMICAL RESISTANT	1
14	215-123	NYLON WASHER	2
15	247-034	SLEEVE	1
16	234-105	PROPELLER	1
17	223-028	DIFFUSER	1
18	215-088	CAPSCREW .50-13UNC X 1.00	4

(IEC) 15 - 20 HP 2 Pole

NOTES:

⚠ WHEN ORDERING A REPLACEMENT MOTOR, SPECIFY THE HP, VOLTAGE, SINGLE OR THREE PHASE, HZ MOTOR I.D. NO. AND RPM.



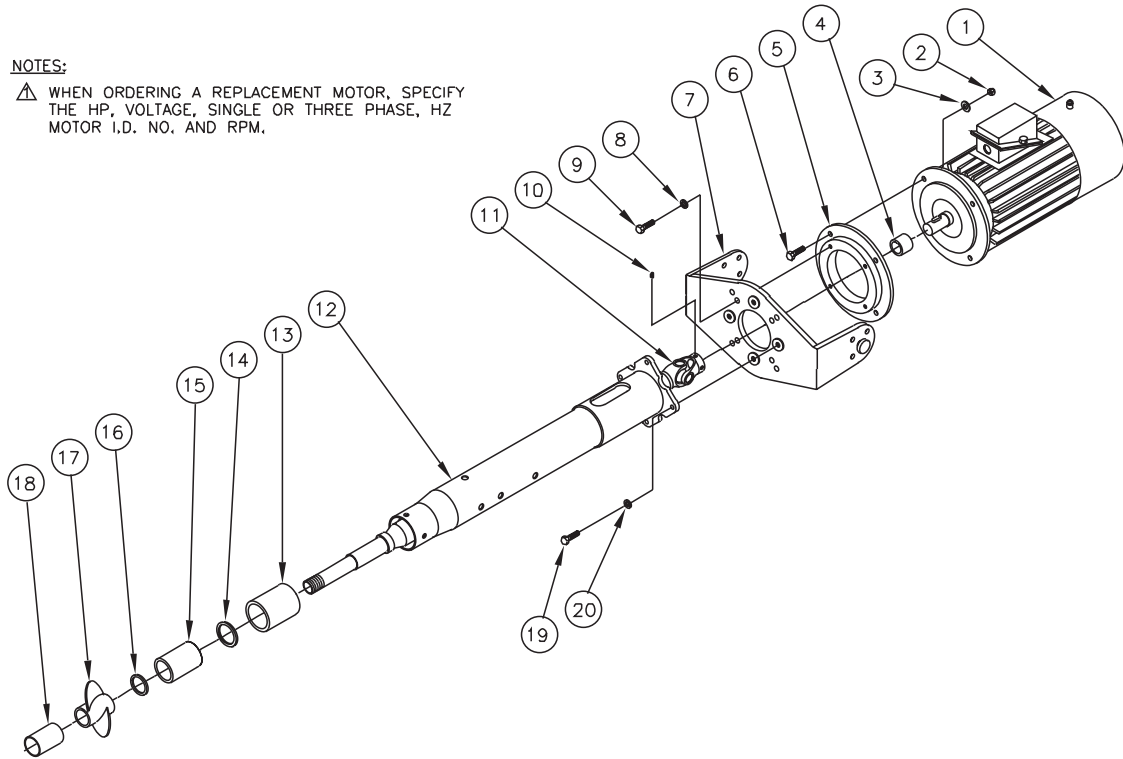
AERATOR HARDWARE

ITEM #	PART #	DESCRIPTION	QTY.
1	-----	MOTOR (IEC)	1
2	215-155	LOCKNUT .625-11UNC	4
3	215-203	FLATWASHER .625	4
4	215-340	MOTOR SPACER	1
5	245-113	ADAPTER FLANGE	1
6	215-154	CAPSCREW .625-11UNC X 2.00	4
7	245-030	MOUNTING FLANGE	1
8	215-100	LOCKWASHER .50	8
9	215-147	CAPSCREW .50-13UNC X 1.25	4
10	215-127	SETSCREW .375-16UNC	2
11	239-123	SHAFT	1
12	330-086	HOUSING	1
13	213-053	BEARING, 15 - 20HP ABRASION RESISTANT	1
	213-026	BEARING, 15 - 20HP CHEMICAL RESISTANT	1
14	215-123	NYLON WASHER	2
15	247-034	SLEEVE	1
16	234-106	PROPELLER, 15 HP	1
	234-125	PROPELLER, 20 HP	1
17	223-028	DIFFUSER	1
18	215-088	CAPSCREW .50-13UNC X 1.00	4

AIRE-O₂® Aerator Assembly (IEC) 25 - 30 HP 4 Pole

NOTES:

⚠ WHEN ORDERING A REPLACEMENT MOTOR, SPECIFY THE HP, VOLTAGE, SINGLE OR THREE PHASE, HZ MOTOR I.D. NO. AND RPM.



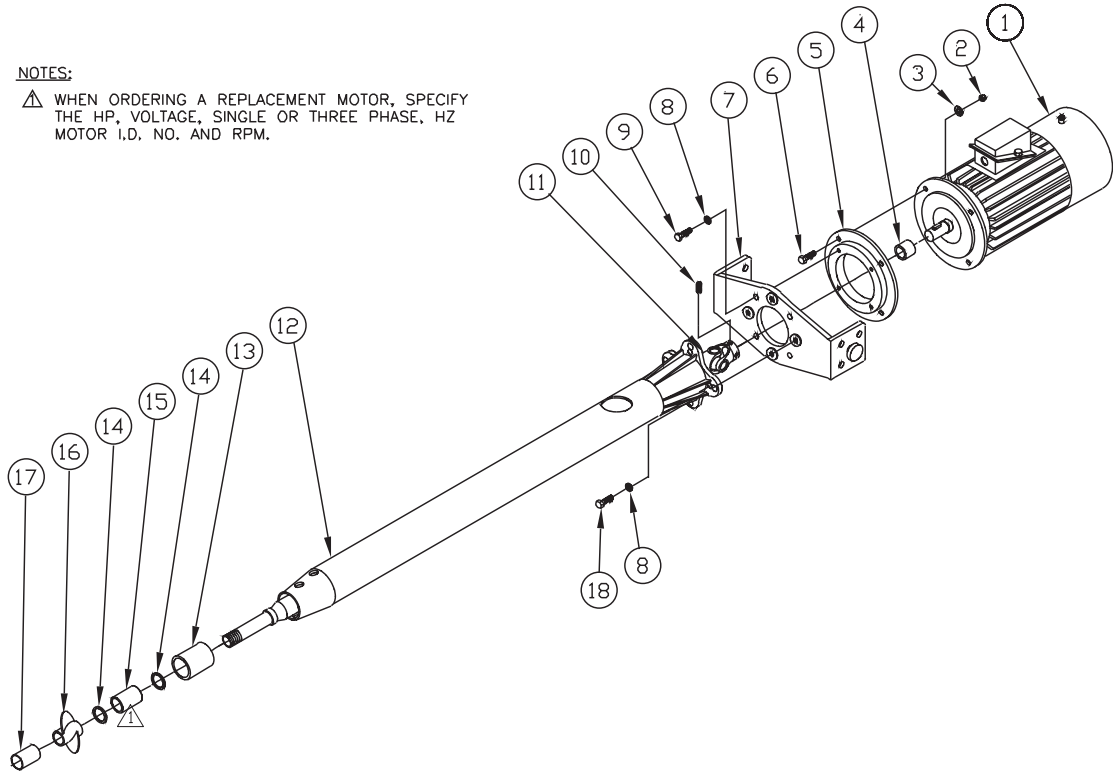
AERATOR HARDWARE

ITEM #	PART #	DESCRIPTION	QTY.
⚠ 1	-----	MOTOR (IEC)	1
2	215-155	LOCKNUT .625-11UNC	4
3	215-387	FLATWASHER .625 REDUCED O.D.	4
4	215-359	MOTOR SPACER	1
5	245-113	ADAPTER FLANGE	1
6	215-154	CAPSCREW .625-11UNC X 2.00	4
7	245-043	MOUNTING FLANGE	1
8	215-100	LOCKWASHER .50	4
9	215-099	CAPSCREW .50-11UNC X 1.50	4
10	215-156	SETScrew .50-13UNC	2
11	239-124	SHAFT	1
12	330-036	HOUSING	1
13	213-054	BEARING, 25 - 30HP ABRASION RESISTANT	1
	213-027	BEARING, 25 - 30HP CHEMICAL RESISTANT	1
14	215-149	NYLON WASHER 3.25 I.D.	1
15	247-033	SLEEVE	1
16	215-201	NYLON WASHER 2.88 I.D.	1
17	234-070	PROPELLER, 25 HP	1
	234-126	PROPELLER, 30 HP	1
18	223-025	DIFFUSER	1
19	215-150	CAPSCREW .625-11UNC X 1.50	4
20	215-151	LOCKWASHER .625	4

(IEC) 10 HP 50 HZ, 4 Pole

NOTES:

△ WHEN ORDERING A REPLACEMENT MOTOR, SPECIFY THE HP, VOLTAGE, SINGLE OR THREE PHASE, HZ MOTOR I.D. NO. AND RPM.



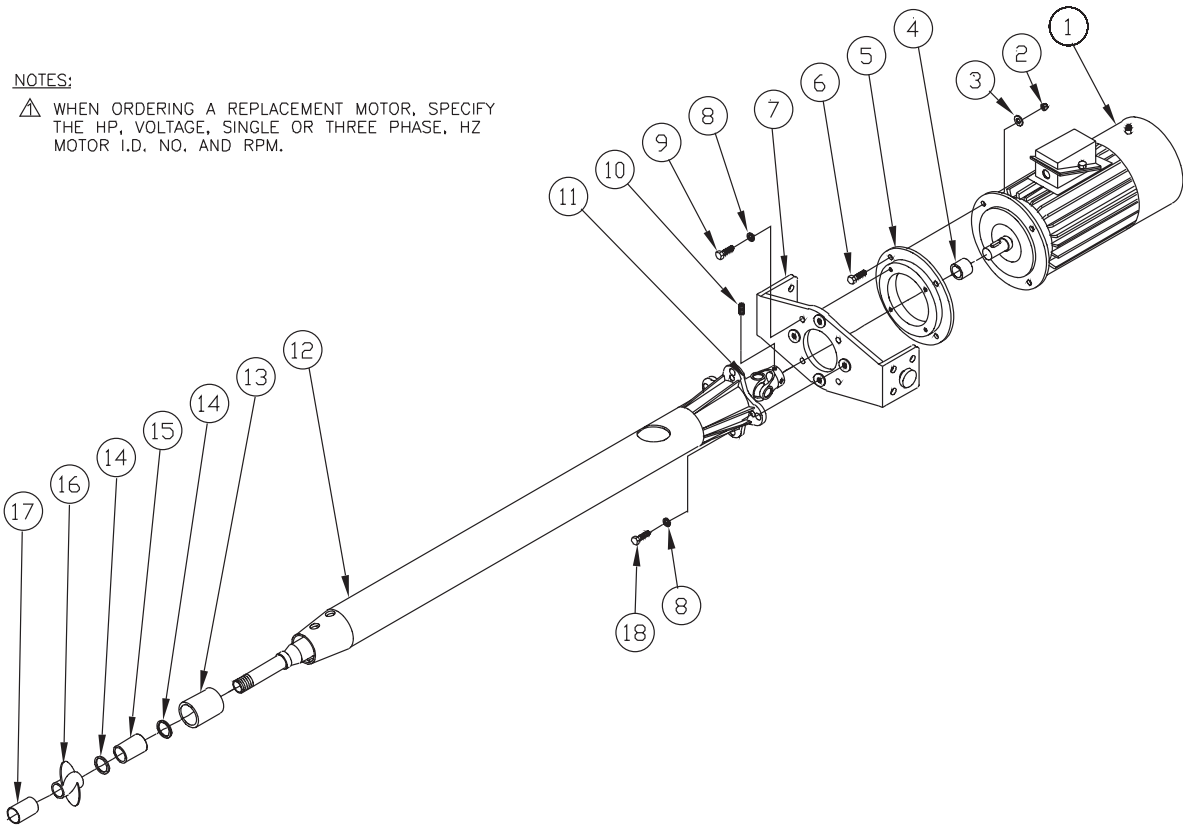
AERATOR HARDWARE

ITEM #	PART #	DESCRIPTION	QTY.
1	-----	MOTOR (IEC) 10	1
2	215-093	LOCKNUT .50-13UNC	4
3	215-388	FLATWASHER .50 REDUCED O.D.	4
4	215-376	MOTOR SPACER	1
5	245-112	ADAPTER FLANGE	1
6	215-092	CAPSCREW .50-13UNC X 2.00	4
7	245-028	MOUNTING FLANGE	1
8	215-100	LOCKWASHER .50	8
9	215-147	CAPSCREW .50-13UNC X 1.25	4
10	215-127	SETSCREW .375-16UNC	2
11	239-135	SHAFT	1
12	330-086	HOUSING	1
13	213-053	BEARING, ABRASIVE RESISTANT	1
	213-026	BEARING, CHEMICAL RESISTANT	1
14	215-123	NYLON WASHER	2
15	247-034	SLEEVE	1
16	234-179	PROPELLER 4 POLE	1
17	223-028	DIFFUSER	1
18	215-088	CAPSCREW .50-13UNC X 1.00	4

(IEC) 15 - 20 HP 50 HZ, 4 Pole

NOTES:

⚠ WHEN ORDERING A REPLACEMENT MOTOR, SPECIFY THE HP, VOLTAGE, SINGLE OR THREE PHASE, HZ MOTOR I.D. NO. AND RPM.



AERATOR HARDWARE

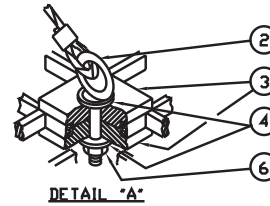
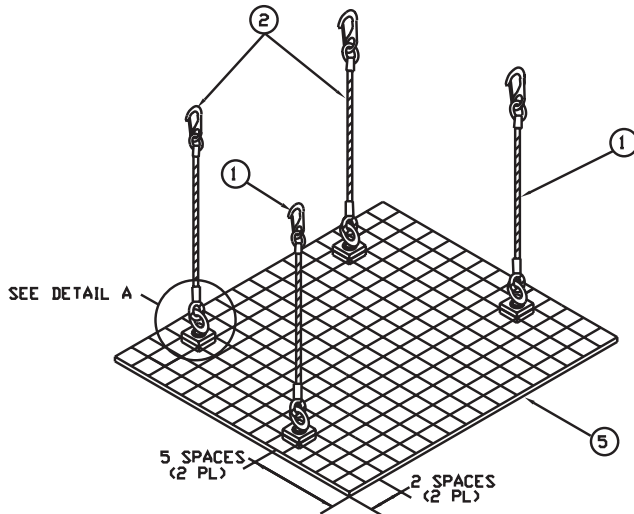
ITEM #	PART #	DESCRIPTION	QTY.
1	-----	MOTOR (IEC) 20	1
2	215-155	LOCKNUT .625-11UNC	4
3	215-203	FLATWASHER .625	4
4	215-540	MOTOR SPACER	1
5	245-113	ADAPTER FLANGE	1
6	215-154	CAPSCREW .625-11UNC X 2.00	4
7	245-030	MOUNTING FLANGE	1
8	215-100	LOCKWASHER .50	8
9	215-147	CAPSCREW .50-13UNC X 1.25	4
10	215-127	SETSCREW .375-16UNC	2
11	239-123	SHAFT	1
12	330-086	HOUSING	1
13	213-053	BEARING, ABRASION RESISTANT	1
	213-026	BEARING, CHEMICAL RESISTANT	1
14	215-123	NYLON WASHER	2
15	247-034	SLEEVE	1
16	234-180	PROPELLER 15 HP	1
	234-280	PROPELLER 20 HP	1
17	223-028	DIFFUSER	1
18	215-088	CAPSCREW .50-13UNC X 1.00	4

3.4 VORTEX SHIELD ASSEMBLY

Install the four vortex shield eye bolts to the frame assembly. (Ref. pages 10 and 12 for eyebolt locations.) Install the four vortex shield cable snap hooks to the eye bolts and install the vortex shield.

NOTE: Proper mounting will suspend the vortex shield plane surface parallel with the water surface.

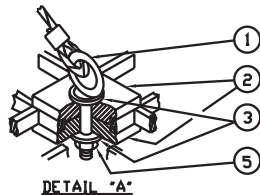
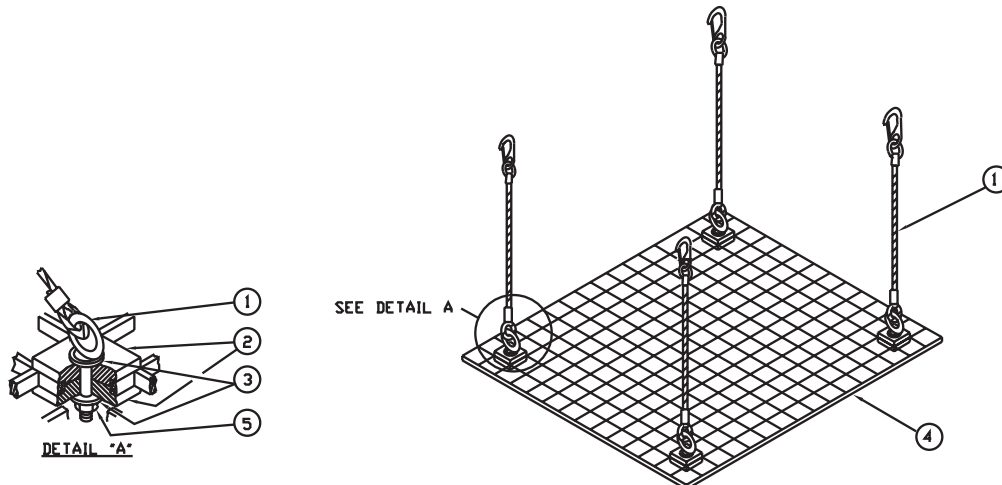
3.4.1 VORTEX SHIELD ASSEMBLY DRAWING



410614 - Tri-Float Vortex Shield

HARDWARE

ITEM #	PART #	DESCRIPTION	QTY.
1	301-044	CABLE ASSEMBLY	2
2	301-047	CABLE ASSEMBLY	2
3	250-105	CABLE ATTACHMENT	8
4	215-104	WASHER, FLAT 3/8"	8
5	240-035	VORTEX SHIELD GRATE	1
6	215-081	LOCK NUT, 3/8-16	4



410591 - Four Float Vortex Shield

HARDWARE

ITEM #	PART #	DESCRIPTION	QTY.
1	301-044	CABLE ASSEMBLY	4
2	250-105	CABLE ATTACHMENT	8
3	215-104	WASHER, FLAT 3/8"	8
4	240-035	VORTEX SHIELD GRATE	1
5	215-081	LOCK NUT, 3/8-16	4

3.5 AIRE-O₂[®] AERATOR ASSEMBLY PLACEMENT

1. Slide or hoist the AIRE-O₂[®] AERATOR and flotation assembly into the water. To hoist the assembly, fasten a sling or chain to each main frame rail just to the front of the motor mount brackets. This is near the balance point for the entire assembly. Lift slowly and check the balance of the assembly before moving.
2. Once the unit has been placed in the water. **Position the AIRE-O₂[®] AERATOR at a 45 degree angle below horizontal.** Secure it with four 1/2" x 1 1/2" bolts through each mount bracket and mounting flange. These bolts will be in the 3 and 9 o'clock positions. (Horizontal)
3. Move the AIRE-O₂[®] AERATOR to its location on the lagoon.

4.0 MOORING OPTIONS

1. Fasten the AIRE-O₂[®] AERATOR to the Mooring cable using the clamps provided. Leave the clamps loose until the AIRE-O₂[®] AERATOR system is located in its operating position in the pond. **(Ref. floatation cable attachment drawings in section 4.3)**
2. Wire the motor using the wiring instructions on the motor and secure the power cable to the frame and cable with tie wraps. **See Electrical pages in Section 9.0 and Power Cable Selection in section 10.**

Note: If the span from shore to shore is too great and more than one unit is attached to span cable, care must be taken in routing electrical cable. The weight of the electrical cable if attached to the span cable might be too great for the aerator to support. If this is the case, other means of routing the electrical cable must be used.

The installation of cable float supports, or overhead support cable are options. Routing the electrical cable on the bottom of the lagoon can be done if UL approved submersible cable is used.

4.1 FLOTATION CABLE ATTACHMENT

Anchoring AIRE-O₂[®] AERATOR flotation assemblies. The variables listed below are considered to determine the most practical anchoring method for a given installation. (See 1-13 below.) They are also used to select wire rope cable size, cable anchors, power cable size, AIRE-O₂[®] AERATOR positioning, anchor weight, anchor shape, and anchor position.

VARIABLES:

1. AIRE-O₂[®] AERATOR horsepower
2. Number of AIRE-O₂[®] AERATOR(s)
3. Water depth
4. Water level fluctuation
5. Dimensions of body of water
6. Shape of body of water
7. Wind and wave action
8. Snow and ice loading
9. Embankment or wall height above water surface
10. Continuous or seasonal use
11. Navigation requirements
12. Maintenance considerations
13. AIRE-O₂[®] AERATOR orientation in body of water

Aeration Industries International, Inc., provides technical assistance on sizing and placement of the AIRE-O₂[®] AERATOR(s). Cabling or anchoring method should be determined before installation.

4.2 CABLE SAG ALLOWANCE

Cable sag is measured at the midpoint of the longest span length between anchor cable supports. Supports include cable anchor posts, aeration flotation, and auxiliary flotation. When installing new anchor cable, sag allowance must be decreased to compensate for in-service stretch.

The following chart lists sag allowances for span-direct anchor cabling configurations. This is the minimum sag allowed. Allowing more sag will place less strain or tension on the cable and its anchors. Under no circumstances should the anchor cable be allowed in the water.

Sag Allowance

Aerator Nominal Power	Sag Allowance at Maximum Span	
	New Cable	Stretched Cable
10 - 30 HP	1' - 6"	2' - 0"

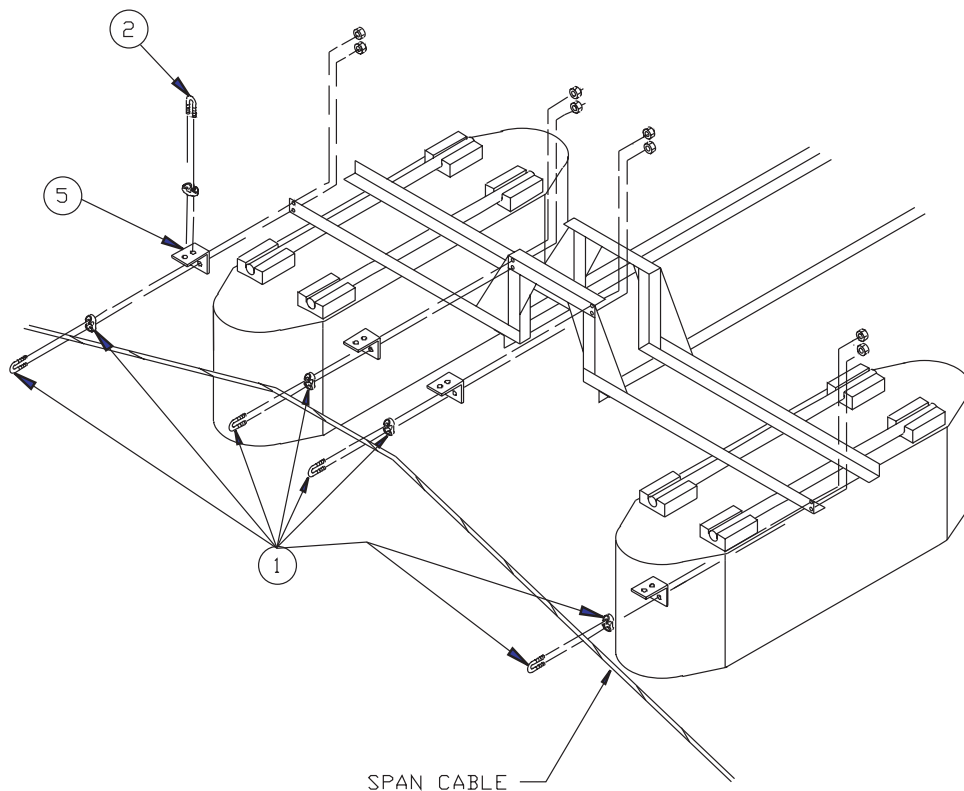
4.3 SPAN DIRECT MOORING 3 & 4 FLOAT

The span direct cabling system will accommodate water level fluctuations up to three feet. To insure proper slack (cable sag), the span direct cables should be installed with the water at its lowest level. If this is impractical, then close observation must be maintained as water levels change to prevent either excessive cable tension or slack.

The standard span-direct cabling attaches the AIRE-O₂[®] AERATOR perpendicular to the cable. Position the cable along the front cross member and attach it with cable clamps.

Once the AIRE-O₂[®] AERATOR unit has been attached to the span cable, run the appropriate electrical cable to the AIRE-O₂[®] AERATOR. Attach it to the cable with plastic ties, leaving slack between each tie.

Note: All flotation assemblies use the following assembly for Span Direct Mooring



△ 1 WHEN ORDERING REPLACEMENT PARTS SPECIFY GALV. OR S.S.

△ 2 ONLY NEEDED WHEN 1/2" WIRE ROPE CLAMPS ARE USED

HARDWARE

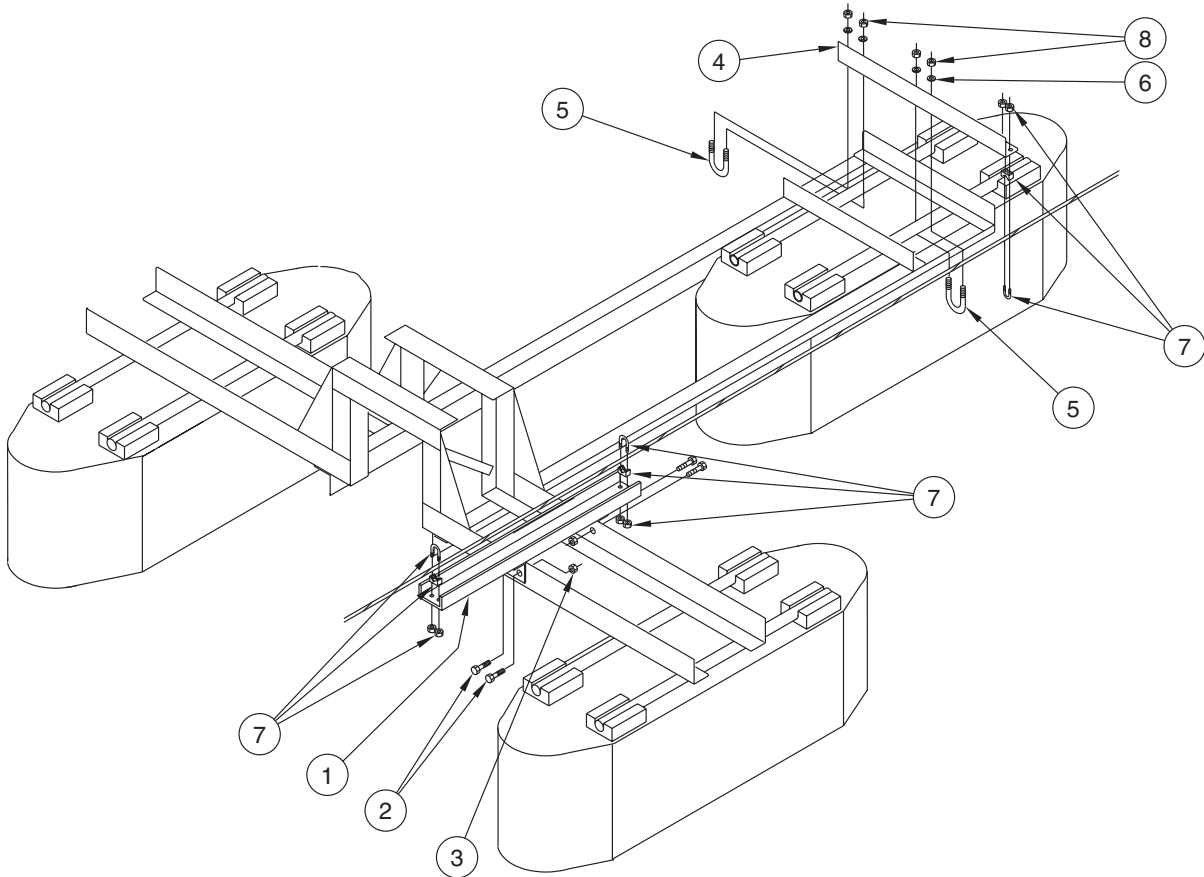
ITEM #	PART #	DESCRIPTION	QTY.
△ 1	221-022	WIRE ROPE CLAMP 3/8", S.S.	4
	221-019	WIRE ROPE CLAMP 3/8", GALV	4
△ 2	221-020	WIRE ROPE CLAMP 1/2", S.S.	4
	221-044	WIRE ROPE CLAMP 1/2", GALV	4
△ 3	215-555	HHCS 7/16-14 x 1-3/4 S.S.	8
△ 4	215-580	LOCKNUT 7/16-14UNC S.S.	8
△ 2 △ 1 5	214-960	SUPPORT ANGLE 1/2" CABLE S.S.	4
	214-959	SUPPORT ANGLE 1/2" CABLE GALV.	4

360-121 **Note: When ordering replacement parts specify either stainless steel or galvanized**

4.4 IN-LINE SPAN MOORING

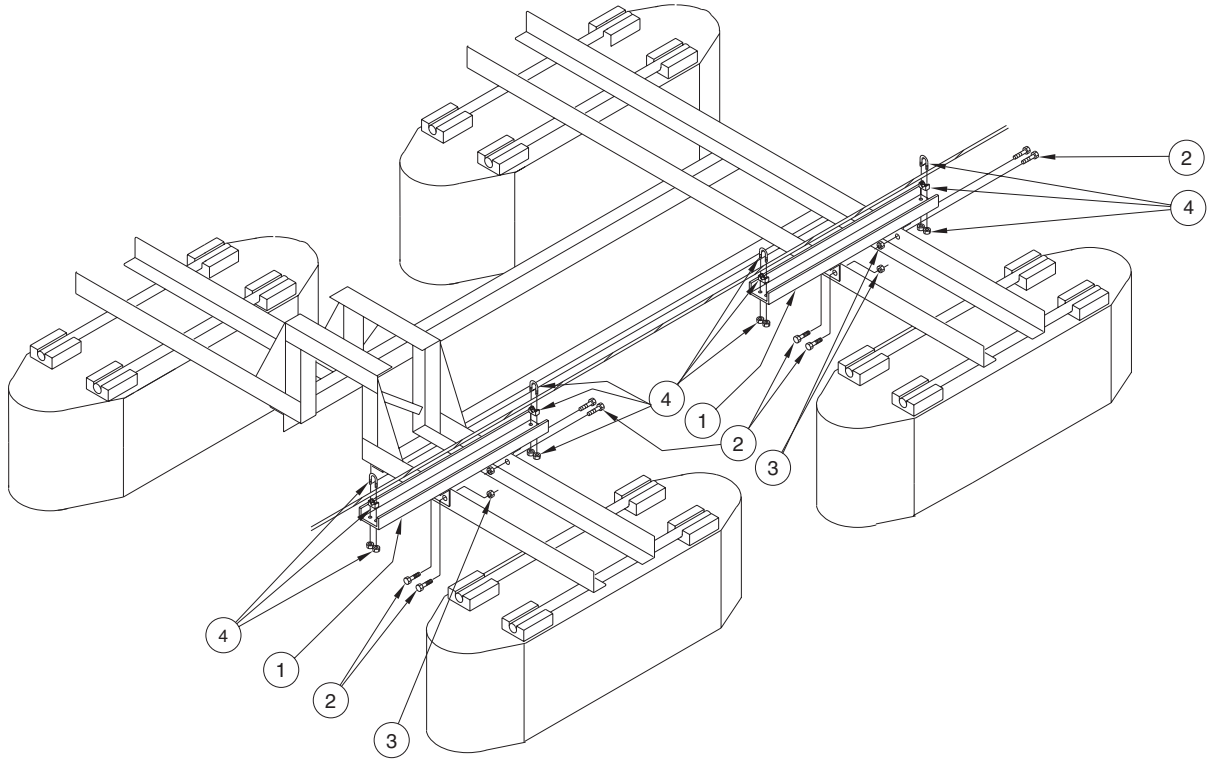
Cable clamps attach the cable to each end of the in-line channel. In certain applications, a channel iron is fabricated to be used in mounting the cable. The channel iron is bolted to the flotation frame. The cable is then fastened to the channel using cable clamps. The specific method used is determined from site factors and is engineered with these factors or requirements in mind.

4.4.1 TRI-FLOAT IN-LINE SPAN MOORING



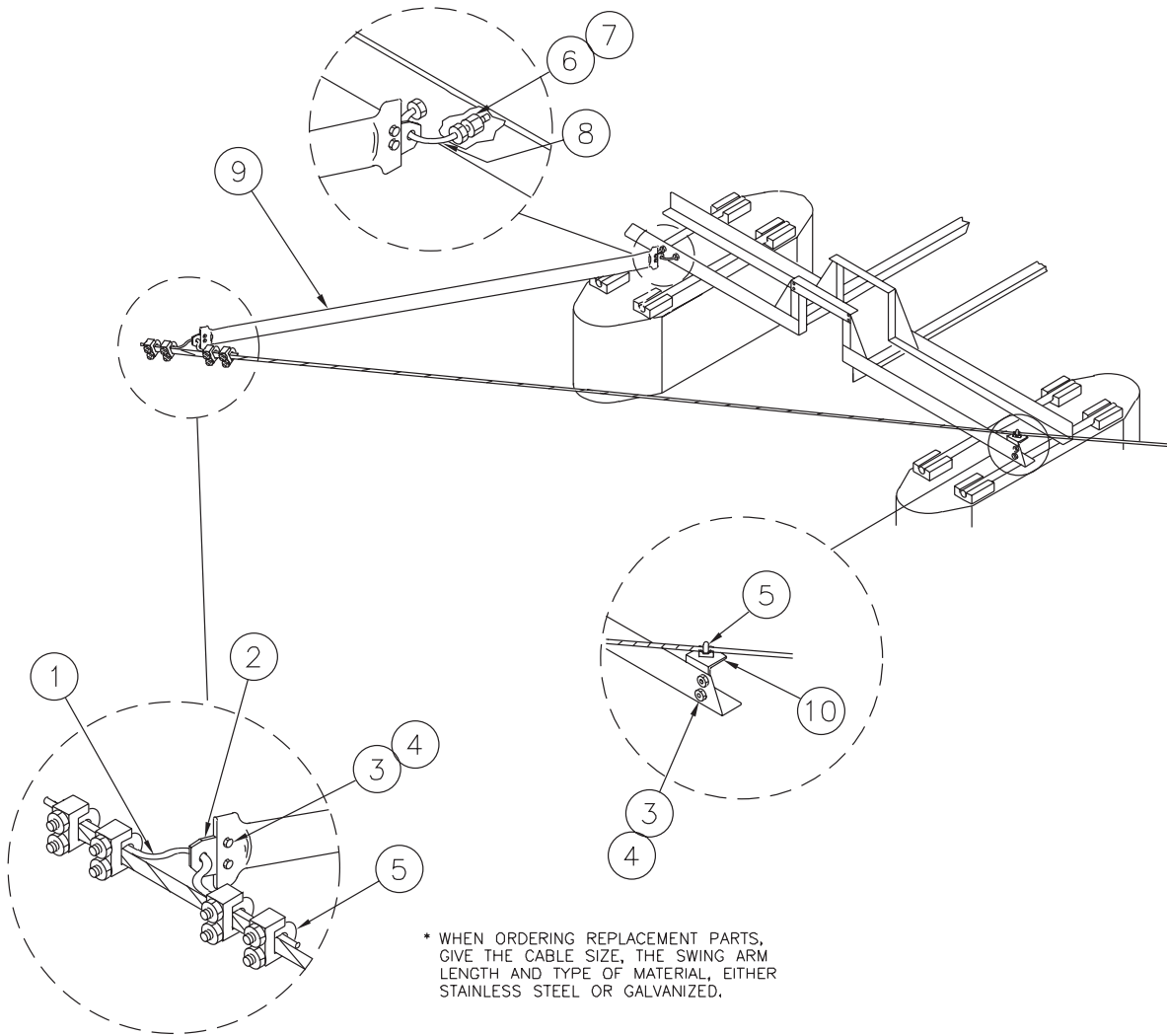
HARDWARE

ITEM #	PART #	DESCRIPTION	QTY.
1	214-341	INLINE CHANNEL, S.S.	1
	214-336	INLINE CHANNEL, GALV	1
2	215-032	CAPSCREW, 3/8" x 1 1/4"	4
3	215-081	LOCK NUT, 3/8"	4
4	214-607	INLINE MT., REAR, S.S.	1
	214-606	INLINE MT., REAR, GALV	1
5	215-184	U-BOLT, 5/16", S.S.	2
	215-022	U-BOLT, 5/16", GALV	2
6	215-027	LOCKWASHER, 5/16"	4
7	221-022	WIRE ROPE CLAMP, 3/8", S.S.	3
	221-019	WIRE ROPE CLAMP, 3/8", GALV	3
8	215-052	HEX NUT, 5/16"	4

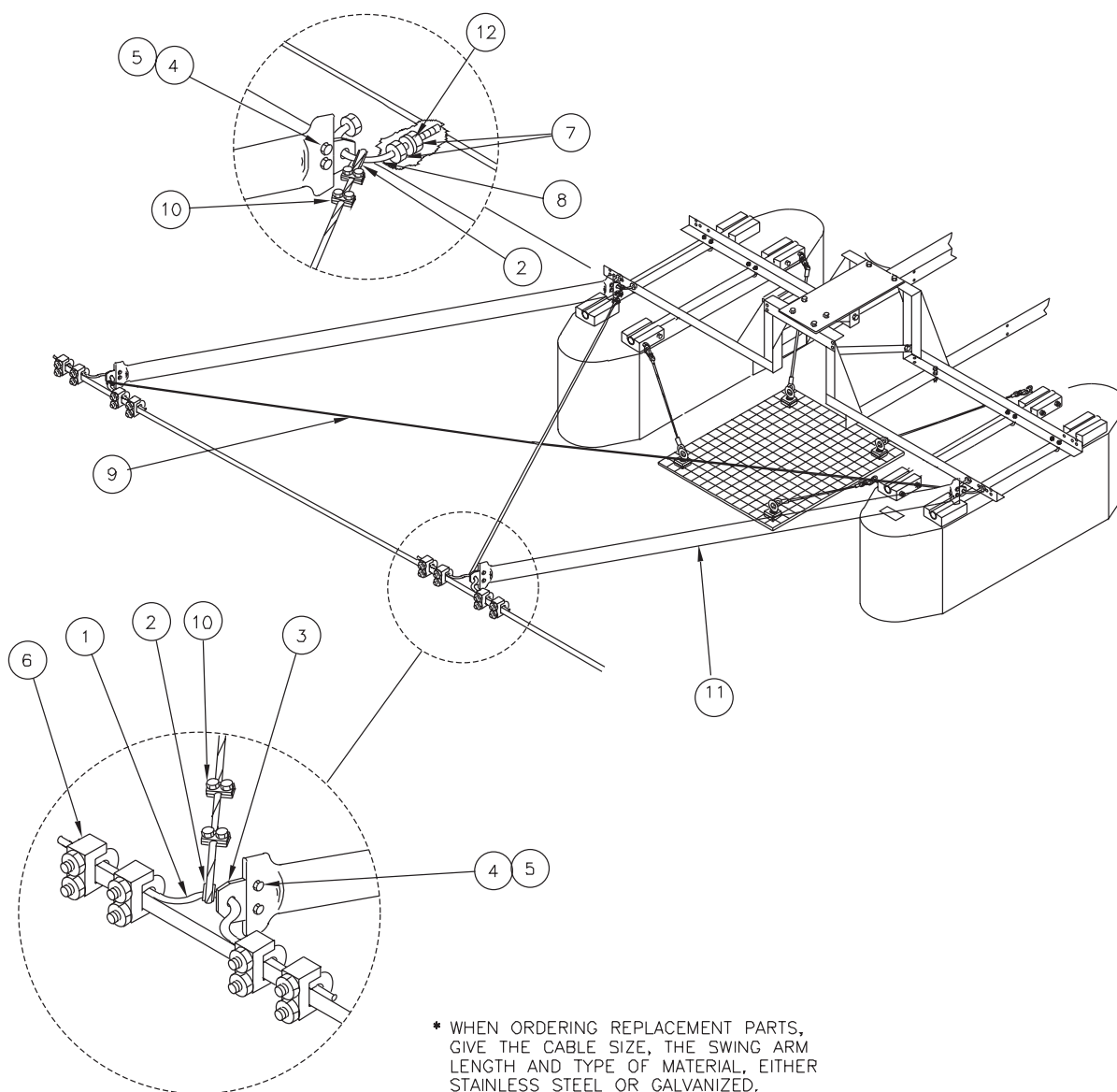


HARDWARE			
ITEM #	PART #	DESCRIPTION	QTY.
1	214-341	INLINE CHANNEL, S.S.	1
	214-336	INLINE CHANNEL, GALV	1
2	215-032	CAPSCREW, 3/8" x 1 1/4"	8
3	215-081	LOCK NUT, 3/8"	8
4	221-020	WIRE ROPE CLAMP, 1/2", S.S.	4
	221-044	WIRE ROPE CLAMP, 1/2", GALV	4

4.4.3 SPAN BRIDLE ANGLED ASSEMBLY



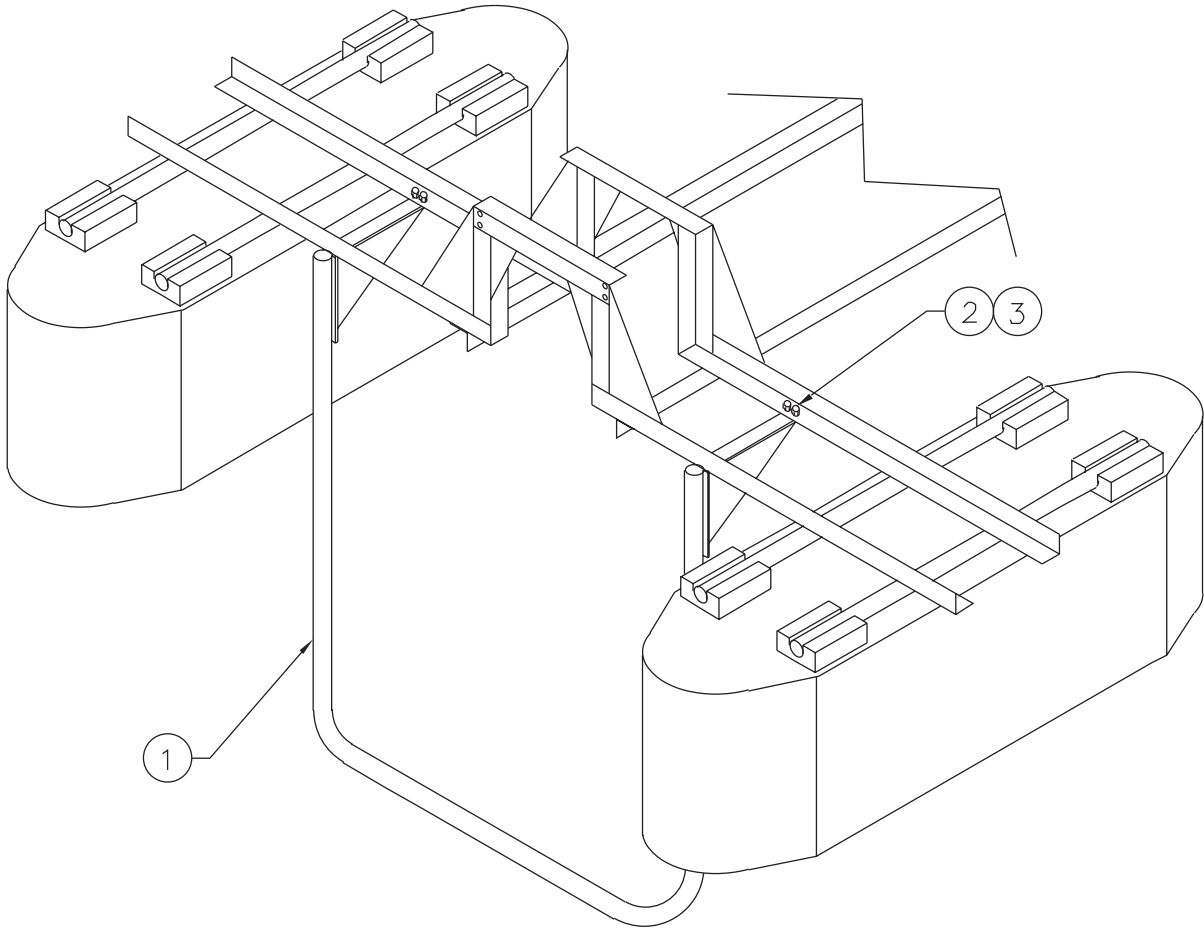
HARDWARE			
ITEM #	PART #	DESCRIPTION	QTY.
1	-----	BRIDLE	1
2	238-098	SWING ARM PIVOT	2
3	215-066	CAPSCREW .375 X 1.00	6
4	215-081	LOCKNUT .375	6
5	-----	WIRE ROPE CLAMP	5
6	215-026	LOCKWASHER, .375	2
7	215-095	HEX NUT .375	4
8	215-160	U-BOLT .375	1
9	238-110	SWING ARM	1
10	214-830	BRACKET, CABLE SUPPORT	1



* WHEN ORDERING REPLACEMENT PARTS, GIVE THE CABLE SIZE, THE SWING ARM LENGTH AND TYPE OF MATERIAL, EITHER STAINLESS STEEL OR GALVANIZED.

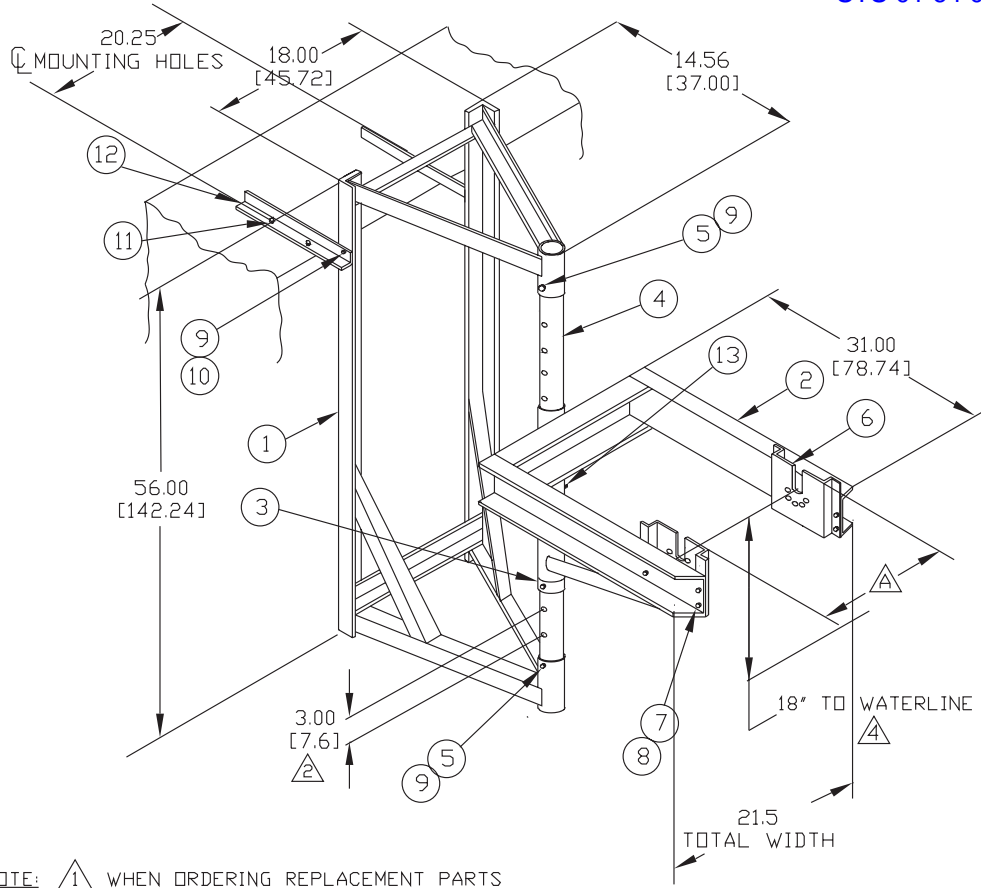
ITEM #	PART #	HARDWARE DESCRIPTION	QTY.
*1	-----	BRIDLE	1
*2	221-008	THIMBLE .25 SS	4
	221-025	THIMBLE .25 GALV	4
*3	-----	SWING ARM PIVOT	4
4	215-066	CAPSCREW .375 X 1.00	8
5	215-081	LOCKNUT .375	8
*6	-----	WIRE ROPE CLAMP	8
7	215-095	HEX NUT .375	8
8	215-160	U-BOLT .375	2
9	105-003	CABLE .25	A/R
*10	221-004	WIRE ROPE CLAMP S.S.	8
	221-026	WIRE ROPE CLAMP GALV.	8
*11	-----	SWING ARM	2
12	215-026	LOCKWASHER .375	4

4.4.5 FLOAT SUPPORT ASSEMBLY



HARDWARE			
ITEM #	PART #	DESCRIPTION	QTY.
1	214-902	FLOAT SUPPORT S.S.	1
	214901	FLOAT SUPPORT GALV.	1
2	215-032	CAPSCREW .375-16UNC X 1.25	8
3	215-081	LOCKNUT .375	8

4.4.6 WALL MOUNT ASSEMBLY 10 - 30 HP GALV. & S.S.



- NOTE:**
- 1 WHEN ORDERING REPLACEMENT PARTS SPECIFY GALVANIZED OR STAINLESS STEEL
 - 2 THE FORK CAN BE ADJUSTED UP 15" AND DOWN 15" FROM THE CENTER MOUNTING HOLE ON THE PIVOT TUBE. THE PIVOT TUBE ALLOWS VERTICAL ADJUSTMENTS IN 3" INCREMENTS AND ALLOWS THE FORK TO SWIVEL 180°.
 - 3. DIMENSIONS IN BRACKETS ARE CENTIMETERS
 - 4 POSITION PIVOT POINT OF MOUNT BRACKET APPROXIMATELY 18" FROM WATERLINE

HARDWARE

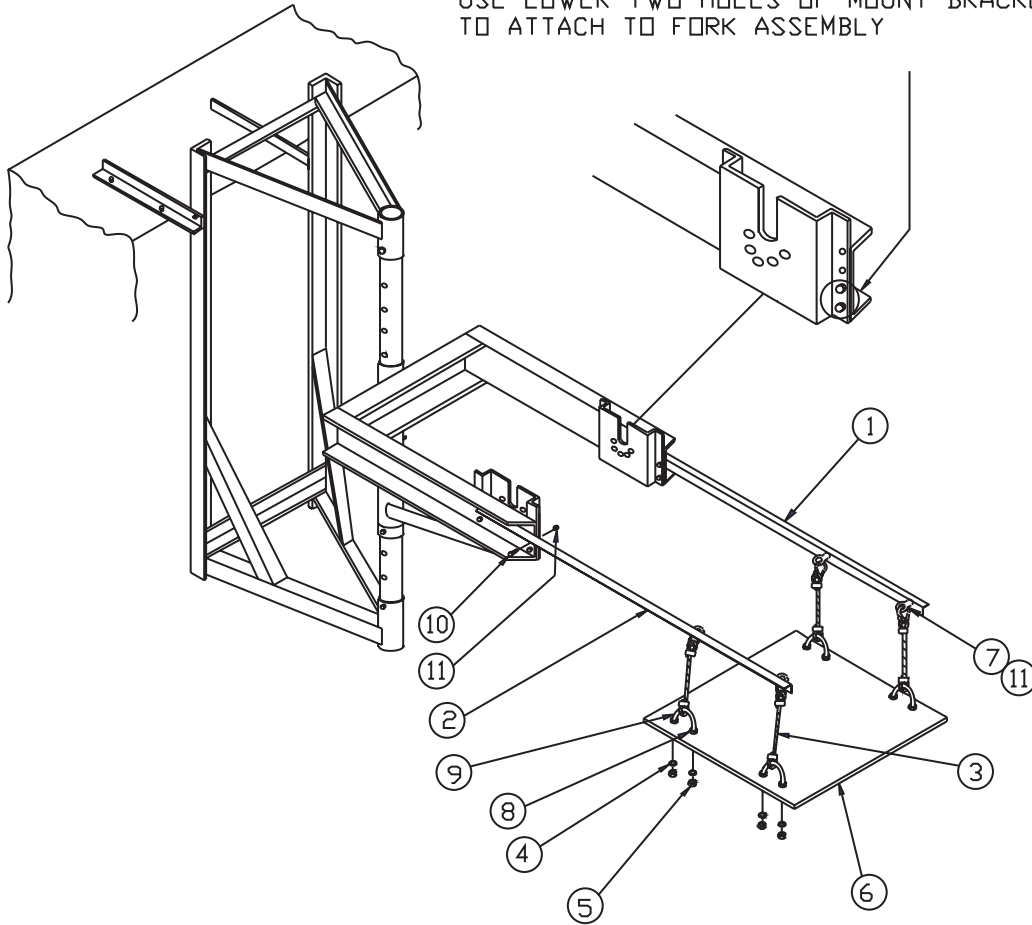
ITEM #	PART #	DESCRIPTION	QTY.
1	214-049	WALL MOUNT, GALV. 10-30HP	1
	214-218	WALL MOUNT, S.S. 10-30HP	1
2	214-369	FORK, GALV. 25-30HP	1
	214-054	FORK, GALV. 10-20HP	1
	214-357	FORK, S.S. 25-30HP	1
	214-223	FORK, S.S. 10-20HP	1
	214-055	COLLAR, GALV	1
3	214-225	COLLAR, S.S.	1
	214-056	PIVOT TUBE, GALV	1
4	214-224	PIVOT TUBE, S.S.	1
	215-145	CAPSCREW .50-13UNC X 3.50	3
6	214-014	MOUNT BRACKET, GALV.	2
	214-061	MOUNT BRACKET, S.S.	2
7	215-032	CAPSCREW .50-13UNC X 1.25	8
8	215-081	LOCKNUT .375-16UNC	8
9	215-093	LOCKNUT .50-13UNC	5
10	215-099	CAPSCREW .50-13UNC X 1.50	2
11	215-125	PARA-BOLT ANCHOR, GALV.	8
	215-165	PARA-BOLT ANCHOR, S.S.	8
12	214-075	ANCHOR BRACE, GALV.	2
	214-226	ANCHOR BRACE, S.S.	2
13	215-088	CAPSCREW .50-13UNC X 1.00	2

360-034

4.4.7 WALL MOUNT VORTEX SHIELD ASSEMBLY

10 - 30HP 60Hz / 10 - 20HP 50Hz & IEC

USE LOWER TWO HOLES OF MOUNT BRACKET TO ATTACH TO FORK ASSEMBLY



① WHEN ORDERING REPLACEMENT PARTS, SPECIFY STAINLESS STEEL OR GALVANIZED, AND MOTOR HP.

② SHOWN FOR REFERENCE, PARTS ARE SUPPLIED WITH WALL MOUNT ASSEMBLY

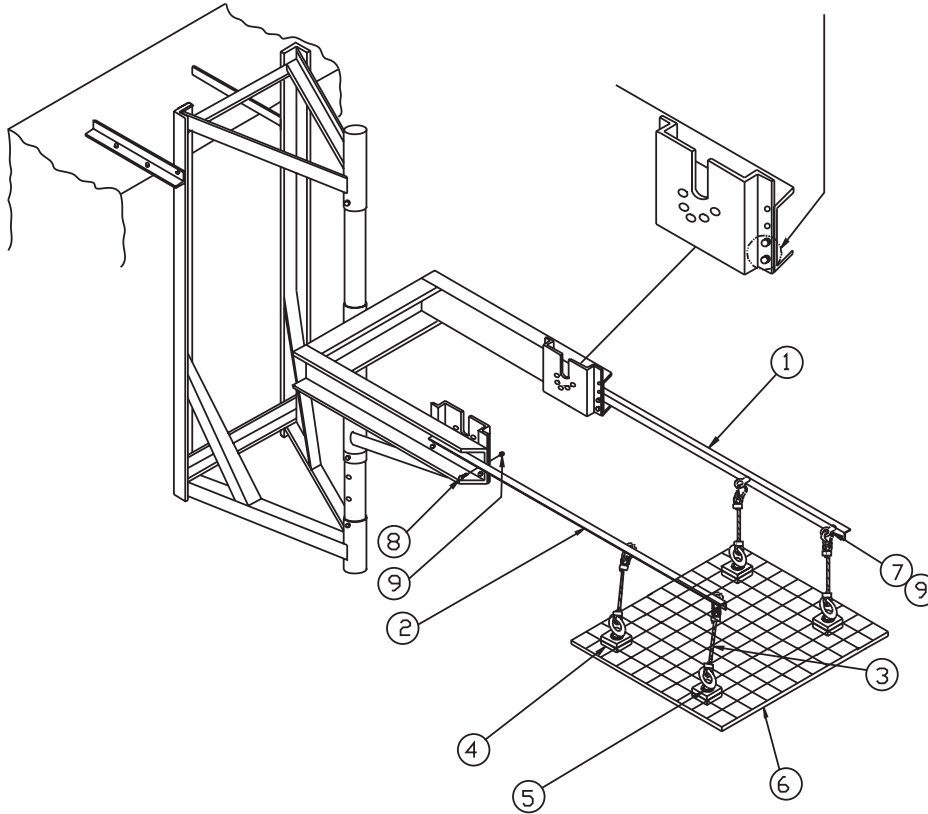
HARDWARE

ITEM #	PART #	DESCRIPTION	QTY.
① 1	214-179	SUPPORT - RIGHT	1
	214-181	SUPPORT - RIGHT, S.S	1
① 2	214-180	SUPPORT - LEFT	1
	214-182	SUPPORT - LEFT, S.S.	1
3	301-003	CABLE ASS'Y	4
4	215-051	FLATWASHER	16
5	215-102	LOCKNUT .31-18UNC	8
6	240-023	VORTEX SHIELD	1
① 7	215-133	EYEBOLT GALV.	4
	215-206	EYEBOLT S.S.	4
8	215-052	HEXNUT .31-18UNC	8
9	215-144	U-BOLT	4
① 10	215-032	CAPSCREW .375-16UNC	4
① 11	215-081	LOCKNUT .375-16UNC	8

360-035

10 - 30HP 4 POLE ASPIRATOR

USE LOWER TWO HOLES OF MOUNT BRACKET TO ATTACH TO FORK ASSEMBLY



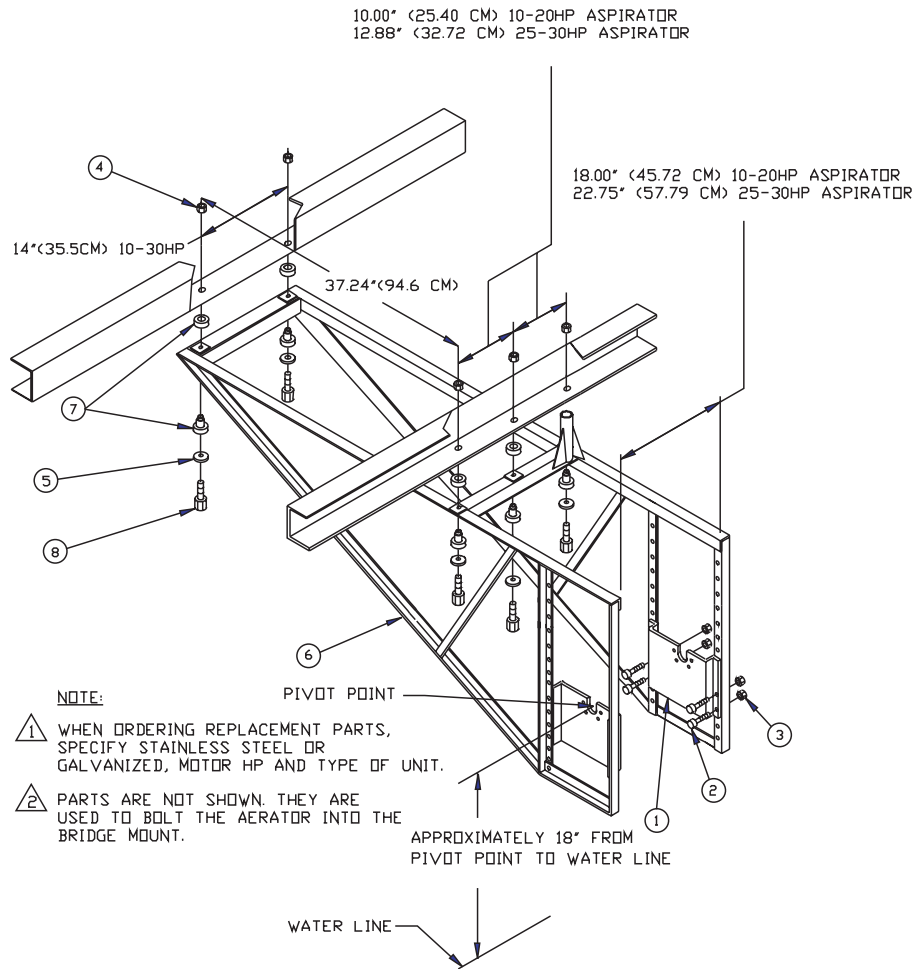
- △ 1 WHEN ORDERING REPLACEMENT PARTS, SPECIFY STAINLESS STEEL OR GALVANIZED, AND MOTOR HP.
- △ 2 SHOWN FOR REFERENCE, PARTS ARE SUPPLIED WITH WALL MOUNT ASSEMBLY

HARDWARE

ITEM #	PART #	DESCRIPTION	QTY.
△ 1	214-179	SUPPORT - RIGHT	1
	214-181	SUPPORT - RIGHT, S.S	1
△ 2	214-180	SUPPORT - LEFT	1
	214-182	SUPPORT - LEFT, S.S.	1
3	301-051	CABLE ASS'Y	4
4	250-105	CABLE ATTACH. BLOCK	8
5	215-104	FLATWASHER .375	8
6	240-037	VORTEX SHIELD	1
△ 7	215-133	EYEBOLT	4
	215-206	EYEBOLT S.S.	4
△ 8	215-032	CAPSCREW .375-16UNC	4
△ 9	215-081	LOCKNUT .375-16UNC	8

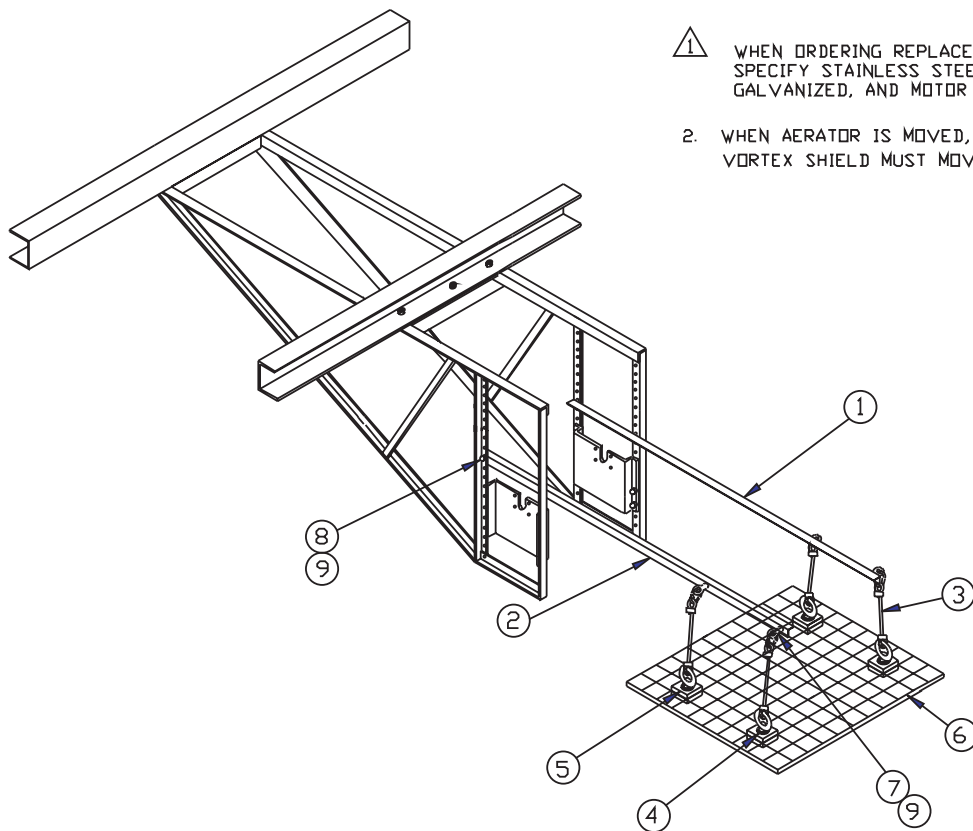
Accessory Options

4.4.8 BRIDGE MOUNT ASSEMBLY GALV. & S.S. 10 - 30 HP 60HZ / 10 - 20HP 50HZ & IEC



HARDWARE

ITEM #	PART #	DESCRIPTION	QTY.
△ 1	214-061	MOUNT BRACKET S.S.	2
	214-014	MOUNT BRACKET GALV.	2
2	215-032	CAPSCREW .375-16UNC X 1.25	8
3	215-081	LOCKNUT .375-16UNC	8
4	215-155	LOCKNUT .625-11UNC S.S.	5
	215-175	LOCKNUT .625-11UNC GALV.	5
5	215-373	SNUBBING WASHER S.S.	5
	215-411	SNUBBING WASHER GALV.	5
△ 6	214-584	BRIDGE MOUNT 10-20 HP S.S.	1
	214-586	BRIDGE MOUNT 25-30 HP S.S.	1
	214-583	BRIDGE MOUNT 10-20 HP GALV.	1
	214-585	BRIDGE MOUNT 25-30 HP GALV.	1
7	215-372	VIBRATION ISOLATOR	5
8	215-374	CAPSCREW .625-11UNC X 4.00	5
△ 9	215-093	LOCKNUT .50-13UNC S.S.	4
	215-157	LOCKNUT .50-13UNC GALV.	4
△ 10	215-099	CAPSCREW .50-13UNC X 1.50	4

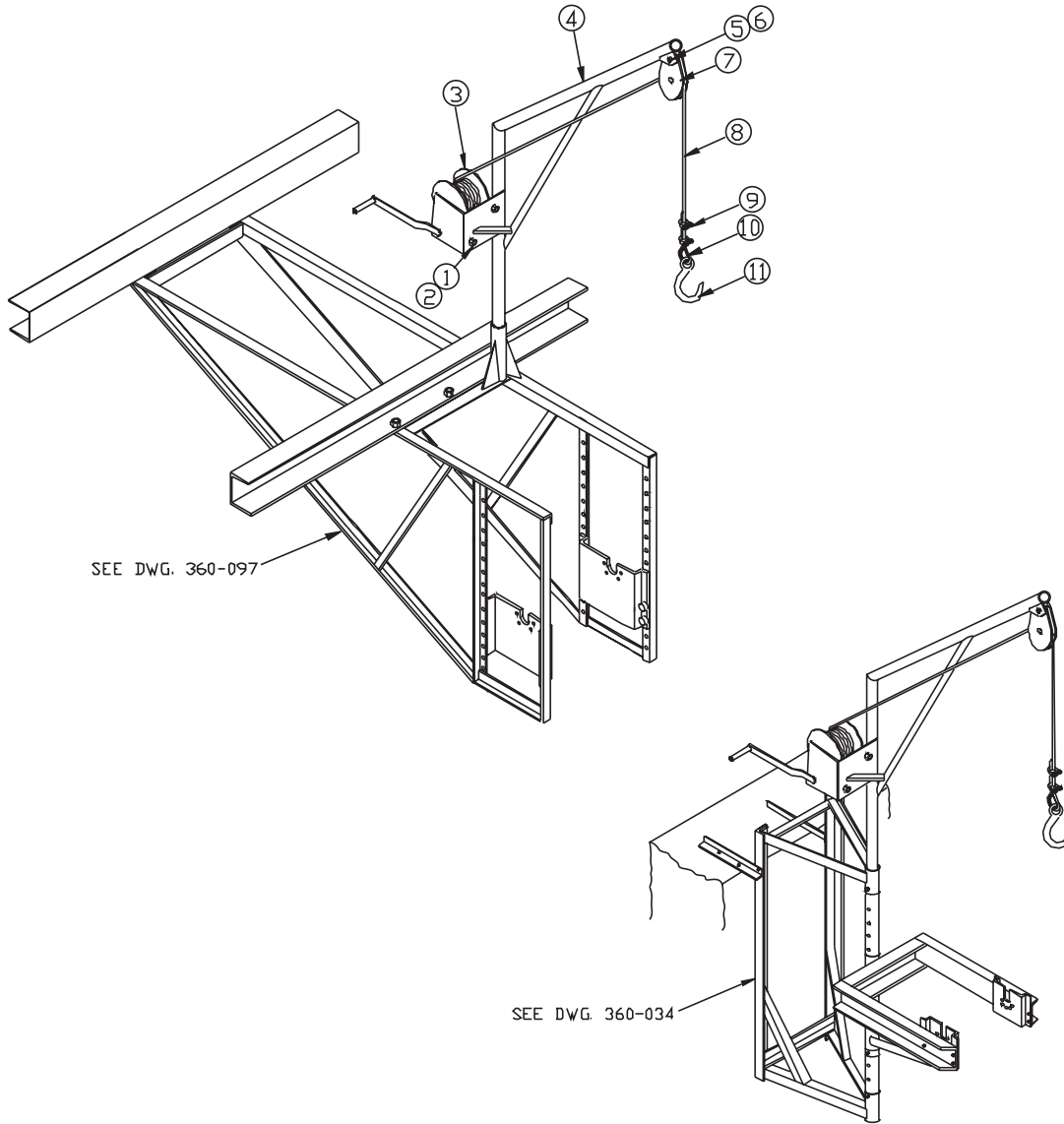


- △ 1. WHEN ORDERING REPLACEMENT PARTS, SPECIFY STAINLESS STEEL OR GALVANIZED, AND MOTOR HP.
- 2. WHEN AERATOR IS MOVED, VORTEX SHIELD MUST MOVE ACCORDINGLY.

HARDWARE

ITEM #	PART #	DESCRIPTION	QTY.
△ 1	214-179	SUPPORT-RIGHT GALV.....	1
	214-181	SUPPORT-RIGHT S.S.	1
△ 2	214-180	SUPPORT-LEFT GALV.....	1
	214-182	SUPPORT-LEFT S.S.	1
3	301-040	CABLE ASSEMBLY	4
4	215-104	FLATWASHER 3/8"	8
5	215-105	CABLE ATTACH. BLOCK	4
6	240-037	VORTEX SHIELD	1
△ 7	215-133	EYEBOLT GALV.	4
	215-206	EYEBOLT S.S.	4
8	215-032	CAPSCREW .375-16UNC	4
9	215-081	LOCKNUT .375-16UNC.....	12

4.4.10 BRIDGE MOUNT CRANE



HARDWARE

ITEM #	PART #	DESCRIPTION	QTY.
1	215-032	.375-16UNC x 1.25" HHCS	3
2	215-081	.375-16UNC LOCKNUT	3
3	251-003	WINCH	1
4	251-008	BOOM	1
5	215-092	.50-13UNC x 2.00" HHCS	1
6	215-093	.50-13UNC LOCKNUT	1
7	251-005	CABLE BLOCK	1
8	005-001	CABLE 3/16" S.S.	15'
9	221-009	CABLE CLAMP	2
10	221-008	THIMBLE	1
11	221-007	SNAP HOOK	1

5.1 ELECTRICAL CHECK

WARNING: The main power supply control panel must be a "Power Out Manual Reset" configuration.

After stoppage of the aerator due to a power outage, voltage spike or any other situation, single or multiple units **must not** be allowed to automatically restart, or damage may occur. The aerators must be either manually bumped and restarted as specified under the start-up section of the O&M manual or a control panel must be supplied using technology similar to a soft start. **Failure to follow this procedure will void the factory warranty.**

WARNING: Do not splice power cable or use quick disconnects between the motor and the power supply cable at the motor or any other place.

WARNING: Always wear an approved life vest when working on the aerator near or over water.

1. Install electrical cable onto the span-direct or in-line mount using plastic wire-ties. Space the wire-ties to limit electrical cable sag between attachments to 2 inches maximum. Excessive sag may allow the cable to oscillate continuously in strong winds leading to wear damage.

WARNING: Keep cables off of walkways if provided.

2. Install the electric cable between the span-cable and the motor junction box along a convenient frame component using wire ties for span-direct or in-line mounts.
3. Electrical cable connection to motor must be completed by a certified electrician using the wiring diagram provided by the motor manufacturer. **Failures due to improper electrical connection are not covered by the warranty.**
4. Electrical cable should not be placed over the sharp edges of the metal frame. Machine vibration and movement due to wind or wave action will cause abrasion to the cable insulation.
5. Mounting of the power cable should prevent any tension on any component. This applies at all points from motor controller to motor junction box.

Use of flexible electrical cable permits easy installation. It allows the AIRE-O₂[®] AERATOR to be tilted-up for maintenance. Properly installed power cable should not be subjected to constant flexing due to wind or wave action. This will assure its long life.

A qualified electrician is to check and record voltage supplied to the operating motor upon start-up. (See Start-Up Procedure in section 5.3).

5.2 MOTOR INTERNAL CONNECTIONS

Your first source of wiring information should be the motor nameplate. Some motors will display wiring information inside the junction box cover. Others may have sheets accompanying the motor. Another source of wiring diagrams are found in the motor wiring diagrams in this manual.

Remove the cover of the motor junction box. The numbered wire lead ends will be identified.

5.3 START-UP PROCEDURE

Prior to start-up, electrical power connections should be completed. The AIRE-O₂[®] AERATOR should be positioned in the water secured by cabling or other means. The propeller should be free and clear of any obstruction. Keep in mind that once the AIRE-O₂[®] AERATOR is started, thrust generated will move the AIRE-O₂[®] AERATOR in the water. The distance it will move depends on cable tension and sag allowance.

WARNING: The AIRE-O₂[®] AERATOR will move or surge when first turned on. No one should be near the unit or in the water when the machine is turned on or while it is running.

CAUTION: The AIRE-O₂[®] AERATOR will move when first turned on. This surge or motion is the result of the thrust created by the unit. All anchoring hardware and/or cabling should be firmly fastened. Personnel should be clear of the AIRE-O₂[®] AERATOR and its propeller.

NOTE: Never run the AIRE-O₂[®] AERATOR out of the water. The lower bearing is water lubricated and will overheat without water lubrication. This may cause severe damage to the bearing and sleeve. This kind of damage is not covered by the warranty.

5.4 ROTATION CHECK

Once the AIRE-O₂[®] AERATOR(s) is anchored securely in position and all the electrical connections are checked for correctness, the AIRE-O₂[®] AERATOR(s) are ready for a rotation test. Check each AIRE-O₂[®] AERATOR individually.

1. Use two people. One operates the ON/OFF switches. **Turn on for less than one second**). The other person observes the AIRE-O₂[®] AERATOR water flow.

CAUTION: Do not operate the AIRE-O₂[®] AERATOR motor in reverse rotation.

2. When visually checking the water flow of the AIRE-O₂[®] AERATOR. **The water flow is the same as a boat with a motor.** With correct operation the water/air mixture flows smoothly away from the unit. Water should not splash up toward the motor end of the unit.
3. If the rotation is wrong, switch or reverse any two of the three power leads in the motor starter or at the motor junction box (three-phase). Single phase motors are reversed by reversing connection of the starter winding leads inside the motor junction box. Most motors have a wiring diagram for reference printed inside the motor junction box cover.

5.5 FUNCTIONAL ELECTRICAL CHECK

Verify the amperage and voltage for each AIRE-O₂[®] AERATOR at the motor control box. The motor should be running at this time. This check should be made only by qualified people.

1. The amperage and voltage readings should be equal to or less than the rating on the motor nameplate.
2. The voltage supply should read approximately the same on all three leads (three phase). Keep a record of both current and voltage readings. (Use sheets provided in the Appendix of this manual.)

These initial readings will provide a reference for comparing with future readings. Any significant change would signal a problem with the motor, propeller or bearing assembly.

5.6 OPERATIONAL CHECK

1. The AIRE-O₂[®] AERATOR should run smoothly and quietly. Consult the troubleshooting guide if noise is excessive.
2. Check for vortexes above the propeller. The vortex shield may need repositioning to eliminate all vortexing. Allowing vortexing to continue may damage the propeller from cavitation.

After the unit runs several minutes, note the operating position of the AIRE-O₂[®] AERATOR unit. The AIRE-O₂[®] AERATOR may have to be repositioned on the cables to point it in the optimum direction. Refer to the AIRE-O₂[®] AERATOR placement drawings provided by Aeration Industries international or the consulting engineer to reference the installation drawing or arrangement.

IMPORTANT: Because of the various environments that the aerator can be subjected to, adjustments in the frequency of inspections will vary. Aeration Industries international Inc. recommends that each aerator is disassembled for thorough inspection of parts at least once a year.

Required Maintenance Summary

- Grease motor bearings.
- Grease the drive shaft U-joint once a year when disassembling for inspection.
- Inspect and clean debris out of the housing and water lubrication holes.
- Inspect the sleeve, lower bearing, propeller, and drive shaft for wear and debris. Replace if required.
- Confirm the propeller and diffuser assembly are tightly seated.
- Confirm all fasteners to the aerator, motor and pontoons assembly are secured.
- Inspect electrical and mooring cables for improper sag and wear. Correct as required.
- Confirm all fasteners to all electrical cables are properly secured.
- Monitor and compare voltage and current readings to start-up readings.
- Clear any debris from the motor breather drain / weep hole.
- Inspect for damaged or missing parts.
- Check for proper tension on the motor cord-grip.

Motor Warranty

CUSTOMER SERVICE
Aeration Industries International, Inc.
P.O. BOX 59144
Minneapolis, MN USA
55459-0144

Affix
proper
postage
and mail

Fold

Fold

COMPLETE WARRANTY ON OTHER SIDE CUT OUT PAGE ALONG VERTICAL DOTTED LINE. ENCLOSE ADDITIONAL PHOTO COPIES IF NEEDED. FOLD PANELS SO WARRANTY VALIDATION IS NOT EXPOSED. EXPOSE TOP ADDRESS PANEL TAPE CLOSED, DO NOT STAPLE. AFFIX PROPER POSTAGE AND MAIL.

Cut along this line

Cut along this line

Cut along this line

5.8 MOTOR WARRANTY VALIDATION

IMPORTANT: Complete this entire form and return to: Aeration Industries International, Inc. to initiate motor warranty protection. See other side for mailing instructions.

CONTRACTOR: _____
 ADDRESS: _____ CITY: _____ STATE/COUNTRY: _____ ZIP: _____
 TEL: _____ FAX: _____ DATE TURNED OVER TO OWNER: _____
 ELECTRICIAN NAME: _____ CO. _____

NAME: _____
 ADDRESS: _____ CITY: _____ STATE/COUNTRY: _____ ZIP: _____
 TEL: _____ FAX: _____
 SIGNATURE: _____ DATE: _____

EQUIPMENT OWNER/CUSTOMER: _____
 CONTACT PERSON: _____ TEL: _____

INSTALLATION/SITE
 ADDRESS: _____
 ADDRESS: _____ CITY: _____ STATE/COUNTRY: _____ ZIP: _____

EQUIPMENT OWNER/CUSTOMER MAIL ADDRESS: _____
 CITY: _____ STATE / COUNTRY: _____ ZIP: _____
 TEL: _____ FAX: _____

Nameplate specifications on your aerator motor(s)

MOTOR:	No.1	No. 2	No. 3	No. 4	No. 5	No. 6
HP/Kw	_____	_____	_____	_____	_____	_____
amps	_____	_____	_____	_____	_____	_____
volts	_____	_____	_____	_____	_____	_____
Hz	_____	_____	_____	_____	_____	_____
phase	_____	_____	_____	_____	_____	_____
RPM	_____	_____	_____	_____	_____	_____
S.F.	_____	_____	_____	_____	_____	_____
ID #	_____	_____	_____	_____	_____	_____

CABLE:

Length size _____

Motor #	Leg 1-Leg 2	Leg 1-Leg 3	Leg 3-Leg 2
_____	_____ volts	_____ volts	_____ volts
_____	_____ volts	_____ volts	_____ volts
_____	_____ volts	_____ volts	_____ volts
_____	_____ volts	_____ volts	_____ volts
_____	_____ volts	_____ volts	_____ volts

Leg 1	Leg 2	Leg 3
_____ amps	_____ amps	_____ amps
_____ amps	_____ amps	_____ amps
_____ amps	_____ amps	_____ amps
_____ amps	_____ amps	_____ amps
_____ amps	_____ amps	_____ amps

Leg 1-GND	Leg 2-GND	Leg 3-GND
_____ volts	_____ volts	_____ volts
_____ volts	_____ volts	_____ volts
_____ volts	_____ volts	_____ volts
_____ volts	_____ volts	_____ volts
_____ volts	_____ volts	_____ volts

Power ON Frequency _____
 Type of over-current protection used? Thermal, Magnetic, other _____
 What is the rating and setting of your over-current protection _____
 For three phase power, is there phase loss protection? (Circle) yes no
 What is the date(s) of aerator(s) start up? _____
 Who performed the initial start-up? _____

**PHOTOCOPY FORM AS REQUIRED TO INCLUDE ALL AERATORS
 REQUIRING WARRANTY VALIDATION**

6.0 MAINTENANCE

6.1 PREVENTIVE MAINTENANCE

Maintenance And Service Schedule

The maintenance record sheet follows on page 50. Make copies and use them to insure documentation and performance of maintenance procedures. File for a maintenance record. Honoring any warranty claim will require these signed, dated, and completed sheets as evidence of proper maintenance.

Daily Observations

Aeration Industries International, Inc., recommends when possible that each unit be observed daily. The AIRE-O₂[®] AERATOR should run quietly without excessive vibration. Also note the flow of water and air from the AIRE-O₂[®] AERATOR. Noise, vibration, and disrupted air or water flow are indicators of operational problems. Daily observation will ensure that problems will be corrected before damage can occur to the AIRE-O₂[®] AERATOR.

Quarterly Inspection

The record sheets on page 50 should be copied for use during scheduled maintenance of the AIRE-O₂[®] AERATOR throughout each year of service. Keep the completed sheets on file as a record of maintenance performed. Copy or reproduce one sheet for each AIRE-O₂[®] AERATOR for each year of service.

Perform inspection and maintenance at 3, 6, 9, and 12 month intervals. The date of service and the name of the servicing person should be recorded.

Assign a number to each AIRE-O₂[®] AERATOR and note its location in the lagoon or basin. This number is used to specify each individual AIRE-O₂[®] AERATOR. Record any changes in location if needed.

Yearly Inspection

Aeration Industries International Inc. recommends disassembly of the AIRE-O₂[®] AERATOR at least once a year for universal U-joint lubrication and to visually inspect bearings, sleeve and shaft for wear or damage.

NOTE: Disassembly and Assembly instructions are covered in the "Service Addendum" in section 14.

6.2 MAINTENANCE AND SERVICE RECORD

	Service Interval			
	3 Month	6 Month	9 Month	12 Month
Maintenance Person, Initials and Actual Date of Service	_____	_____	_____	_____
Grease motor bearings 3 month interval -see section in manual on lubrication procedure. Use lithium-based grease. (Ref Page 42)	_____	_____	_____	_____
Grease universal joint, one a year when disassembled for inspection.	_____	_____	_____	_____
Check all bolts on the AIRE-O ₂ [®] AERATOR and flotation for tightness.	_____	_____	_____	_____
If span bridle cabling is used, check the cable bridle attachment for wear.	_____	_____	_____	_____
Check electrical connections, power cable condition, and power cable fastenings.	_____	_____	_____	_____
Lower unit inspection of propeller and bearing. Keep record of service performed	_____	_____	_____	_____
Inspect the Blower filter every 3 months and replace if dirty. (Maximum filter life is 6 months)	_____	_____	_____	_____
Measure and record voltage at each leg.				
Leg1 - Leg2	_____	Volts _____	Volts _____	Volts _____
Leg2 - Leg3	_____	Volts _____	Volts _____	Volts _____
Leg3 - Leg2	_____	Volts _____	Volts _____	Volts _____
Measure and record amp draw at each leg.				
Leg1	_____	Amps _____	Amps _____	Amps _____
Leg2	_____	Amps _____	Amps _____	Amps _____
Leg3	_____	Amps _____	Amps _____	Amps _____
Estimated cumulative hours in operation.	_____	Hrs _____	Hrs _____	Hrs _____

Record below any observations or additional repairs performed. Identify the specific unit by number and indicate date.

DANGER: Voltage and current readings should be measured in the control box or panel, not at the motor. Readings should be taken by qualified personnel familiar with using volt and amp meters.

7.0 AIRE-O₂[®] AERATOR SERVICE PROCEDURES

7.1 AIRE-O₂[®] AERATOR SERVICE

The AIRE-O₂[®] AERATOR shaft-housing assembly may be removed for servicing without the need for removing the heavy motor. This permits leaving the AIRE-O₂[®] AERATOR installation in place, simplifying routine maintenance. AIRE-O₂[®] AERATOR(s) may be pivoted raising the propeller out of the water so that inspection, lubrication, and repairs can be made. If motor repair or replacement is to be performed, then a hoist will be needed. A boat will be needed to service AIRE-O₂[®] AERATOR(s) mounted on floats.

NOTE: Disassembly and Assembly instructions are covered in the "Service Addendum" in section 14.

DANGER: Turn off electrical power and lock the AIRE-O₂[®] AERATOR "out of service" before servicing . Use lock-Out Cards.

1. Turn the motor off and lock the unit out of service.
2. Approach the AIRE-O₂[®] AERATOR (using the boat) to reach the motor mounting brackets. Disconnect the vortex shield to take it out of the way.
3. Loosen the four mounting bolts, permitting the AIRE-O₂[®] AERATOR to tip to a nearly horizontal position. This lifts the propeller and housing assembly out of the water. Lock the motor assembly in the nearly horizontal position by replacing a bolt and nut through the mount bracket slot and a hole in the mounting flange.
4. Move the boat around the AIRE-O₂[®] AERATOR flotation to approach the propeller end with the rear of the boat. Position the boat between the pontoons and under the AIRE-O₂[®] AERATOR , Inspect the AIRE-O₂[®] AERATOR. The points listed may be followed in any order. The specific items checked will prevent problems and extend service life.

7.2 INSPECT THE AIRE-O₂[®] AERATOR

1. Check the bolts on the housing and motor mounting flange and retighten.
2. Look for any signs of corrosion.
3. Check the flotation unit for any loose bolts, parts, or damage. Correct as necessary.
4. The propeller and diffuser should be free of debris.
5. Closely examine the propeller and diffuser for indication of wear Slight propeller wear grooves are acceptable if the profile or shape of the propeller blade is not affected. Should wear be extensive, replace the worn item.
6. Remove any debris obstructing the bearing water lubrication holes. These holes are located in the lower end of the housing just above the propeller.
7. Visually inspect the bearing for wear. Wear grooves should be visible and even. Replace the bearing and sleeve if the wear grooves are gone or uneven wear is evident replace the bearing.

Note: Replace the sleeve if it is showing any wear.

8. Manually turn the shaft. The sleeve should rotate with the shaft. Keeping the propeller tight will hold the sleeve to the shaft. If the sleeve slips on the shaft it must be replaced to prevent further damage to the shaft.
9. To properly inspect the sleeve both the diffuser and the propellers must be removed. Remove the nylon washer and slide the sleeve off the shaft. The sleeve must be replaced to prevent additional damage if there are grooves, chips or signs of cracking.

Note: The sleeve must rotate with the drive shaft

10. The hollow shaft should be open and free of debris.
11. Attach a rat tail (bottle) brush to a rod. Use it to clean the interior of the shaft. Be sure the brush reaches to the air intake holes.
12. Manually turn the shaft. It should turn freely. If it does not, check the motor bearings and elastomeric bearings (surrounding the sleeve) for binding. (See "Problem Analysis" pages 56-59.)
13. Lubricate the grease zerk fitting at the universal joint. Access to the zerk fitting is attained by removing the propeller and the four bolts that hold the housing to the mounting flange. Slide the housing away from the motor to expose the universal joint. Grease and reassemble.

NOTE: See lubrication instructions in section 7.3)

14. Examine electrical cable, cable mounting, and connections. If insulation is damaged, repair the damage or replace the cable. All fastenings should be secure.
(Do not under any circumstances splice the power cable.)
15. The positioning or securing of the wire rope cable should be in satisfactory condition with clamps or mounting devices properly tightened.

Once the above checks have been completed, the AIRE-O₂[®] AERATOR motor should be positioned as it was before Steps 3 and 4. Tighten bolts securely.

7.3 LUBRICATION

An adequate procedure and schedule of bearing lubrication is necessary to prolong bearing life yet prevent motor damage from over greasing.

The motor manufacturer's standard recommendation are that all motors should be greased every 3 months

The motor should be warm and should have been operating at least 20 minutes immediately prior to lubrication.

Examine the motor to determine the procedure to be used. Where Alemite or zerk fittings are provided, clean the fittings. Insert the lubrication fitting on the motors provided with plugs.

Remove both upper and lower grease relief plugs before greasing. Check for hardened grease by inserting a wire into the grease relief tube to clean it. **Evidence of hardening or waxy grease would require through cleaning of the tube.**

Grease both the upper and lower bearings of the motor. Use a limited amount of **lithium based** grease.

WARNINGS:

- **Do not pump grease through the bearing to "Flush" it out. Excessive greasing is detrimental to motor life.**
- **The motor should be "Off" when greasing or performing other maintenance.**

After greasing, **run the motor one hour before replacing the relief plugs.** This allows excess grease to be purged or any pressure build-up to be relieved.

U- Joint Lubrication

Lubricate the grease zerk fitting once a year when the unit is disassembled for inspection.

LUBRICATION VOLUME

FRAME SIZE	1800 RPM And Slower	3600 RPM
182 Thru 215	0.5 Cu. In.	0.5 Cu. In.
254 Thru 286	1.0 Cu. In.	1.0 Cu. In.
324 Thru 365	1.5 Cu. In.	1.5 Cu. In.
404 Thru 449	2.5 Cu. In.	1.0 Cu. In.

Recommended lithium based greases are:

- General Electric D6-A2C5
- Shell Oil Company's Dolium R
- Chevron Oil's SRI No. 2
- Texaco Premium RB. Use lithium based grease.

8.0 PROBLEM ANALYSIS

8.1 PROBLEM ANALYSIS OVERVIEW

The purpose of the troubleshooting guide is to help you recognize problems, make the corrections, and thus avoid costly down time for the AIRE-O₂® AERATOR. Various “Symptoms,” “Possible Causes,” and “Corrections” are provided to help guide you.

The AIRE-O₂® AERATOR is thoughtfully engineered to permit servicing by two people. Problems are simple to diagnose and to correct.

Experience indicates that most problems fall into one of three areas:

- Motor / Electrical
- Mechanical
- Operational

Have qualified personnel performing troubleshooting and maintenance work. Read and follow safety precautions in this manual.

The unit may be pivoted in the mounting bracket for servicing, minimizing the need for a hoist.

8.2 PROBLEM ANALYSIS CHARTS

SYMPTOMS	POSSIBLE CAUSES	CORRECTIONS
Excessive current	Inaccurate ammeter	Re-calibrate amp meter
Excessive current, running no load	High line voltage of 5 - 10% over rating	Consult power company, or consider changing transformer taps
Excessive current	Motor overloaded	Propeller fouled Replace motor with one of correct voltage rating
	Motor voltage rating does not match power system supply	Consult power company, or consider changing transformer taps
	Bearing drag	Replace or lubricate
Motor runs wrong direction	Incorrect motor wiring	Switch two of three power leads (3 phase, only)
Motor runs hot	Overloaded	Clean fouled propeller
		Replace seized motor bearings or seized lower bearing
		Reduce load or number of starts per hour, or increase motor size
	Blocked ventilation	Clean external ventilation system and check fan
	High ambient temperature	Eliminate external interference to motor ventilation
	Unbalanced input current	Balance supply voltage-check motor leads for tightness (3 phase, only)

8.2 PROBLEM ANALYSIS CHARTS

SYMPTOMS	POSSIBLE CAUSES	CORRECTIONS
Motor will not start	Rotor or bearing locked	Shut off power check shaft for free rotation Be sure proper sized overload relays are in each of the three phases of the starter Refer to National Electrical Code
	Motor wired wrong	Check wiring diagram
	Phase wrong	Consult power company
	Excessive start load	Clean fouled propeller. Replace seized motor bearings or seized lower bearing.
Voltage drop exceeds 2% of supply voltage	Inadequate power supply	Consult power company
	Undersized supply lines	Increase line size or shorten length
	Each phase lead run in separate conduits	All three phase leads shall be in a single conduit, per National Electrical Code. (This applies only to metal conduit with magnetic properties).
Overload relays trip at start-up (See also slow starting)	Slow starting (10 to 15 seconds or more) due to high inertia load	Clean fouled propeller. Replace seized motor bearings or seized lower bearing
	Low voltage at motor terminals	Improve power supply or increase line size
	Overload	Check for mechanical problems
	Unbalanced input current	Balance supply voltage
	Single phasing	Consult power company
	Too frequent starting or intermittent overloading	Reduce frequency of starts and overloading or increase motor size
	High ambient starter temperature	Reduce ambient temperature or provide outside source of cool air

8.2 PROBLEM ANALYSIS CHARTS

SYMPTOMS	POSSIBLE CAUSES	CORRECTIONS
Overload relays trip at start-up (Continued)	Wrong size relays	Correct size per nameplate current of motor - relays have built-in allowance for service factor current. Confirm line drop is included.
RPM below specification	Excessively low voltage	Check power Source, consult power company
Note: A reasonable load or voltage drop will reduce speed only 1 - 2%. Reported RPM drop of greater amount would be questionable.	Inaccurate method of measuring RPM	Re-calibrate RPM meter
	Single phased	Shut off power-if it cannot be restarted, it may be single phased
Excessive electrical noise or chatter under load	Mismatched controller	Check for properly sized overload relays
		Refer to National Electric Code
Slow starting (10 - 15 seconds or more)	Excessive voltage	Consult with power company or check with certified electrician
Noisy motor bearing (listen to bearings)	Internal fit of bearing too tight	Replace bearing-check fit
	Internal fit of bearing too loose	Replace bearing-check fit
	Bearing destroyed	Replace bearing
Mechanical noise and excessive vibration	Loose mounting	Check motor and housing mounting bolts
	AIRE-O ₂ [®] AERATOR or motor out of balance	Disconnect the AIRE-O ₂ [®] AERATOR from the motor and restart motor.
	a. Motor imbalance	Have motor serviced at a certified motor repair shop
	b. Shaft or propeller imbalance	Check for worn bearing. Clean the shaft and propeller, or return propeller / shaft assembly to Aeration Industries international Inc. for balance check.

8.2 PROBLEM ANALYSIS CHARTS

SYMPTOMS	POSSIBLE CAUSES	CORRECTIONS
Intermittent or no air coming out	Fouled propeller	Clean propeller
	Plugged shaft	Clean shaft
	Worn bearing or sleeve	Replace bearing or sleeve
	Detached prop or shaft	Reassemble propeller and shaft assembly or replace (Check for damage)
	Propeller on backward or loose	Check propeller illustration in the assembly section
	Propeller vortexing	Add vortex shield
Float assembly bucking and vortexing	Propeller vortexing	Add vortex shield
	Loose mounting cable	Tighten cable
Float assembly moving on pond	insufficient anchoring	Re-anchor to shore
Water splashing back	Motor running in reverse	Reverse two of the power leads at the electrical control box (3 phase, only)

9.0 ELECTRICAL ASSEMBLY

9.1 THREE PHASE MOTOR CONNECTIONS

Wound coil ends terminating in the motor junction box are identified as T1, T2, T3, T4, etc. You will find 3, 6, 9, or 12 of these leads.

L1, L2, and L3 identify 3 - phase line connecting points.

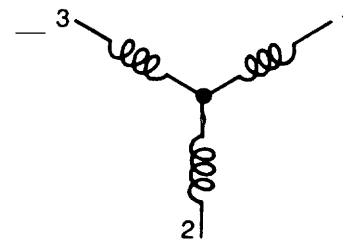
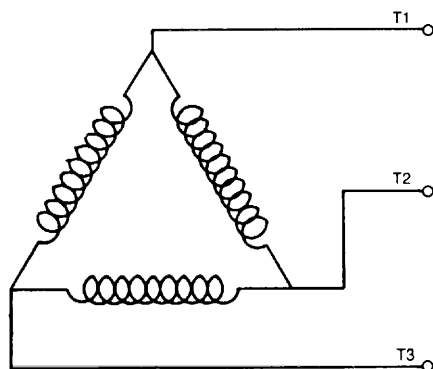
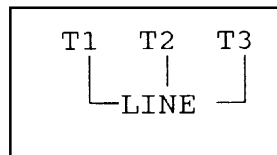
Reversing motor rotation on 3 - phase motors involves interchanging any two of the three power leads, L1, L2, or L3.

A small triangle may be used to indicate Delta winding connections. Y connections may be called "star-" or "wye" The following configurations apply to both 50 Hz and 60 Hz motors.

3 LEADS

Motors with 3 leads (T1, T2, T3) are connected directly to L1, L2, and L3 in any order. Reversing any two of the three leads will reverse the rotation of the motor.

Delta or Y Connected
Single Voltage
Across The Line Starting

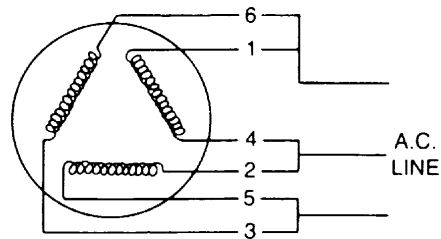
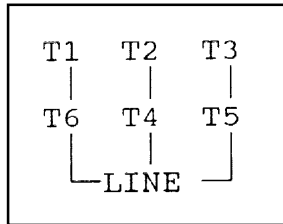


6 LEADS

Motors with 6 leads are usually special voltage or large horsepower motors and are wired for single voltages.

The following connection configuration applies to both 50 Hz and 60 Hz motors. Motors may be wound in Delta or Y configurations. Therefore, it is important to consult the wiring diagram on the nameplate or inside the cover of the conduit box. If there is no wiring diagram and you are unsure of winding configuration, call Motor manufacturer or Aeration Industries International, Inc.

Delta-Connected
Single Voltage
Across The Line Starting



9.1 THREE PHASE MOTOR CONNECTIONS

9 LEADS

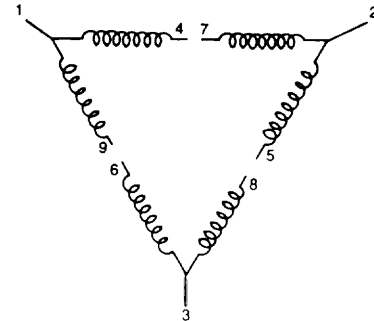
Motors with 9 leads are dual voltage motors manufactured as either Delta or as Y connected. This configuration cannot be changed at the motor junction box. Therefore, it is important to consult the wiring diagram on the nameplate or inside the cover of the conduit box.

The following connection configurations apply to both 50 Hz and 60 Hz motors. If there is no diagram and you are unsure of winding configuration, call motor manufacturer or Aeration Industries International, Inc.

Nine lead motors cannot be wired for Y start / Delta run.

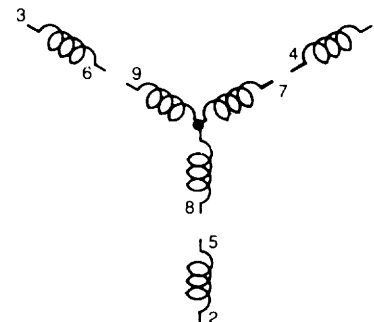
Delta Connected
Dual Voltage
Across The Line Starting

Parallel Delta	Series Delta
LOW VOLTAGE	HIGH VOLTAGE
<pre> T4 T9 T6 T8 T5 T7 T2 T3 T1 └───┴───┘ LINE </pre>	<pre> T4 T9—T6 T8—T5 T7 T2 T3 T1 └───┴───┘ LINE </pre>



Y Connected
Dual Voltage
Across The Line Starting

Parallel Y	Series Y
LOW VOLTAGE	HIGH VOLTAGE
<pre> T4—T5—T6 T7 T8 T9 T1 T2 T3 └───┴───┘ LINE </pre>	<pre> T4 T5 T6 T7 T8 T9 T1 T2 T3 └───┴───┘ LINE </pre>



12 LEADS

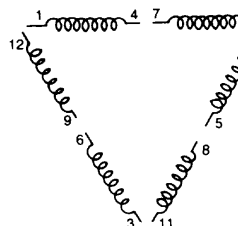
Motors with 12 leads are dual voltage motors and are typically provided in Y configuration for 1 hp to 5 hp and Delta configurations for 7.5 hp and larger. They are wired with coils in series (high voltage) or in parallel (low voltage). The following connection configurations apply to both 60 Hz and 50 Hz motors, **except for 575 volt 60 Hz and 660 volt 50 Hz, which are listed separately on the next page.**

The motors can be started across the line or they may be switched for Y start/Delta run.

Part winding start may also be used to minimize starting current draw.

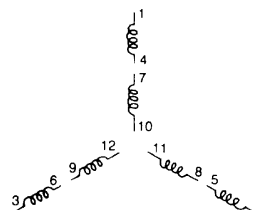
Delta Connected (7.5 hp)

Parallel Delta	Series Delta
LOW VOLTAGE	HIGH VOLTAGE
<pre> T4 T9 T6 T8 T5 T7 T10 T11 T12 T2 T3 T1 -----LINE----- </pre>	<pre> T4 T9---T6 T8---T5 T7 T10 T11 T12 T2 T3 T1 -----LINE----- </pre>



Y Connected (1 hp to 5 hp)
Across The Line Starting

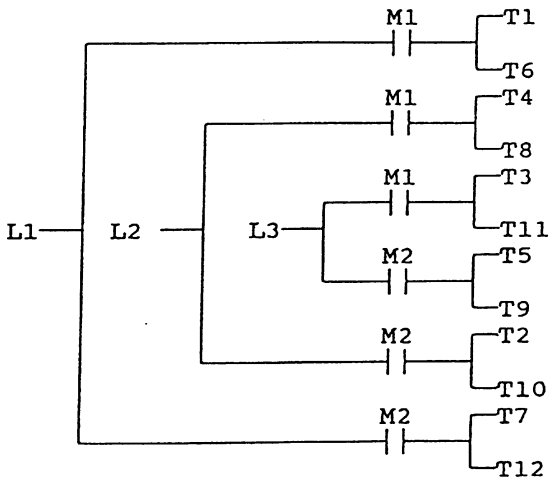
Parallel Y	Series Y
LOW VOLTAGE	HIGH VOLTAGE
<pre> T10-T11-T12 T4---T5---T6 T7 T8 T9 T1 T2 T3 -----LINE----- </pre>	<pre> T10-T11-T12 T7 T8 T9 T4 T5 T6 T1 T2 T3 -----LINE----- </pre>



9.1 ELECTRICAL CONNECTIONS

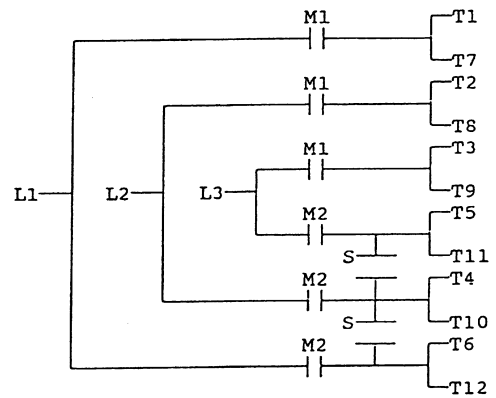
Part Winding Starting
Connection At Low Voltage
(M2 should be energized 2 seconds after M1 is energized)

	START	RUN
M1	Close	Close
M2	Open	Close



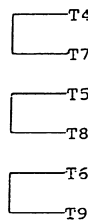
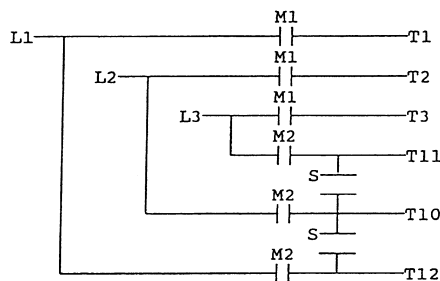
Y Start - Delta Run
Low Voltage

	START	RUN
M1	Close	Close
M2	Open	Close
S	Close	Open



Y Start - Delta Run
High Voltage

	START	RUN
M1	Close	Close
M2	Open	Close
S	Close	Open



10.0 POWER CABLE SELECTION

10.1 POWER CABLE SIZE/LENGTH SELECTION OVERVIEW

The following charts will aid in determining the power cable conductor size for a given horsepower and installation distance.

In the interest of long motor life, it is recommended that voltage drop between the motor controller and the motor be less than 2% of the motor nameplate voltage. This design criterion is particularly important where motors are to operate reliably under high ambient temperature and “brown out” voltage conditions.

The recommendations are based upon information obtained from the 2002 National Electric Code (NEC).

Certain installation may pose unusual design problems. Consult with Aeration Industries International, Inc. before committing to designs that may compromise motor life.

NOTE: When using the Power Cable Selection Charts it is helpful to highlight the particular line which applies to the AIRE-O₂[®] model HP you have purchased.

10.2 CABLE SELECTION BY VOLTAGE CHARTS

HP ¹	FLA ²	x 125% ³	208 VAC 3Ø														Nominal cable weight ^{LB} / _F
			Voltage Drop ≤ 2% (Cable Length In Feet)														
Allowable Ampacities ⁵	# 14	# 12	# 10	# 8	# 6	# 4	# 3	# 2	# 1	1 / 0	2 / 0	3 / 0	4 / 0	ml ⁴ 2	cmI 30	cmI 35	cmI 400
1	4.6	5.8	35	50	65	85	100	115	130	150	175	200	230	255	285	310	335
2	7.5	9.4	347	533	849	1342	1664	2189									
3	10.6	13.3	213	327	521	823	1021	1343	1701	2126	2551						
5	16.7	20.9	150	231	368	582	722	950	1204	1504	1805	2345					
7.5	24.2	30.3	95	147	234	370	458	603	764	955	1146	1488	1848	2204			
10	30.8	38.5	66	101	161	255	316	416	527	659	791	1027	1275	1521	1797	2081	2396
15	46.2	57.8	52	80	127	200	249	327	414	518	621	807	1002	1195	1412	1635	1883
20	59.4	74	—	53	85	134	166	218	276	345	414	538	668	797	941	1090	1255
25	74.8	94	—	—	66	104	129	170	215	268	322	418	520	620	732	848	976
30	88	110	—	—	—	83	102	135	171	213	256	332	413	492	581	673	775
40	114.4	143	—	—	—	—	87	114	145	181	217	282	351	418	494	572	659
50	143	179	—	—	—	—	—	88	112	139	167	217	270	322	380	440	507
60	169.9	212	—	—	—	—	—	—	—	112	134	174	216	257	304	352	406
75	211.2	264	—	—	—	—	—	—	—	—	113	146	182	217	256	296	341
100	272.8	341	—	—	—	—	—	—	—	—	—	—	146	174	206	238	275
125	343.2	429	—	—	—	—	—	—	—	—	—	—	—	—	159	185	213
150	396	495	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

¹ HP indicates rated horsepower obtained from motor nameplate.

² FLA (full-load amperes) obtained from NEC Table 430-150. Full-Load Current, Three Phase Alternating Current.

³ Cable length calculations are based on 125% motor full-load amperage (FLA), NEC Article 430-22 (A).

For special motors wired for Wye-Start, Delta-Run, the selection of conductors between the controller and the motor may be based on 58 percent of the motor full-load current [NEC 430.22 (C)]. It is recommended that the contractor/electrician contact Aeration Industries for recommended wiring sizing.

⁴ Kcmil indicates wire size in circular mils

⁵ Allowable Ampacities, obtained from NEC Table 310-16, Ampacities of Insulated Conductors - Copper Conductor at 75° C, "—" indicates inadequate Ampacity.

NOTE: Length calculations are based on resistance values obtained from NEC Table 9, AC Resistance and Reactance for 600 VAC Cables, 3 Phase, 60 Hz, 75° C (167° F). Typically the power cable is sized using the distance between the junction box on the shore and the motor, this being referred to as the "hard wire" connection. The power cable between the junction box and the controller is then sized separately using this new distance. This is especially critical where there is a great distance to a central control station and a heavier gage wire is required.

10.2 CABLE SELECTION BY VOLTAGE CHARTS

HP ¹	FLA ²	FLA ² x 125% ³	# 14	# 12	# 10	230 VAC 3Ø										Voltage Drop ≤ 2% (Cable Length In Feet)									
						# 8	# 6	# 4	# 3	# 2	# 1	1/0	2/0	3/0	4/0		mi ⁴ 2	cmil 30	cmil 35	cmil 400					
<i>Allowable Ampacities⁵</i>																									
1	4.2	5.3	20	25	35	50	65	85	100	115	130	150	175	200	230	255	285	310	335						
2	6.8	8.5	99	156	259	399	635	1004	1245	1638	2075	2593													
3	9.6	12.0	70	110	184	283	450	711	882	1160	1469	1837	2204												
5	15.2	19.0	44	70	116	178	284	449	557	733	928	1160	1392	1808	2245										
7.5	22	27.5	—	48	80	123	196	310	385	506	641	802	962	1249	1551	1850	2186	2531							
10	28	35.0	—	—	63	97	154	244	302	398	504	630	756	981	1219	1453	1718	1989	2290						
15	42	52.5	—	—	—	65	103	163	202	265	336	420	504	654	813	969	1145	1326	1527						
20	54	68	—	—	—	—	80	126	157	206	261	327	392	509	632	754	891	1031	1187						
25	68	85	—	—	—	—	—	100	124	164	207	259	311	404	502	598	707	819	943						
30	80	100	—	—	—	—	—	85	106	139	176	220	265	344	427	509	601	696	802						
40	104	130	—	—	—	—	—	—	—	107	136	170	203	264	328	391	462	535	617						
50	130	163	—	—	—	—	—	—	—	—	—	136	163	211	263	313	370	428	493						
60	154	193	—	—	—	—	—	—	—	—	—	—	137	178	222	264	312	362	416						
75	192	240	—	—	—	—	—	—	—	—	—	—	—	143	178	212	250	290	334						
100	248	310	—	—	—	—	—	—	—	—	—	—	—	—	—	164	194	225	259						
125	312	390	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	206						
150	360	450	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—						
<i>Nominal cable weight^{LB/FT}</i>			0.104	0.157	0.286	0.387	0.532	0.793	0.986	1.187	1.743	2.087	2.587	3.037	4.688	n.a.	n.a.	n.a.	n.a.	n.a.					

¹ HP indicates rated horsepower obtained from motor nameplate.

² FLA (full-load amperes) obtained from NEC Table 430-150. Full-Load Current, Three Phase Alternating Current.

³ Cable length calculations are based on 125% motor full-load amperage (FLA), NEC Article 430-22 (A).

For special motors wired for Wye-Start, Delta-Run, the selection of conductors between the controller and the motor may be based on 58 percent of the motor full-load current [NEC 430.22 (C)]. It is recommended that the contractor/electrician contact Aeration Industries for recommended wiring sizing.

⁴ Kcmil indicates wire size in circular mils

⁵ Allowable Ampacities, obtained from NEC Table 310-16, Ampacities of Insulated Conductors - Copper Conductor at 75° C, "—" indicates inadequate Ampacity.

NOTE: Length calculations are based on resistance values obtained from NEC Table 9, AC Resistance and Reactance for 600 VAC Cables, 3 Phase, 60 Hz, 75° C (167° F). Typically the power cable is sized using the distance between the junction box on the shore and the motor, this being referred to as the "hard wire" connection. The power cable between the junction box and the controller is then sized separately using this new distance. This is especially critical where there is a great distance to a central control station and a heavier gage wire is required.

HP ¹	FLA ²	x 125% ³	# 14	# 12	# 10	# 8	# 6	# 4	# 3	# 2	# 1	Voltage Drop ≤ 2% (Cable Length In Meters)							
												1 / 0	2 / 0	3 / 0	4 / 0	mi ⁴ 2	cm ¹ 30	cm ¹ 35	cm ¹ 400
Allowable Ampacities ⁵			20	25	35	50	65	85	100	115	130	150	175	200	230	255	285	310	335
1	2.3	2.9	148	232	386	594	946	1495	1853	2438									
2	4	5.0	85	133	222	342	544	859	1066	1402	1776	2220							
3	5.4	6.8	63	99	164	253	403	637	789	1039	1316	1644	1973	2563					
5	8.9	11.1	38	60	100	153	244	386	479	630	798	998	1197	1555	1931	2302			
7.5	12.2	15.3	28	44	73	112	178	282	349	460	582	728	873	1134	1409	1680	1985	2298	
10	16.1	20.1	21	33	55	85	135	214	265	348	441	552	662	860	1068	1273	1504	1742	2006
15	23.5	29.4	—	23	38	58	93	146	181	239	302	378	453	589	731	872	1031	1193	1374
20	32	40	—	—	28	43	68	107	133	175	222	277	333	432	537	640	757	876	1009
25	38	48	—	—	—	36	57	90	112	148	187	234	280	364	452	539	637	738	850
30	45	56	—	—	—	30	48	76	95	125	158	197	237	308	382	455	538	623	718
40	59	74	—	—	—	—	37	58	72	95	120	151	181	235	291	347	410	475	547
50	71	89	—	—	—	—	—	48	60	79	100	125	150	195	242	289	341	395	455
60	85	106	—	—	—	—	—	—	50	66	84	104	125	163	202	241	285	330	380
75	100	125	—	—	—	—	—	—	—	56	71	89	107	138	172	205	242	280	323
100	133	166	—	—	—	—	—	—	—	—	—	67	80	104	129	154	182	211	243
125	158	198	—	—	—	—	—	—	—	—	—	—	67	88	109	130	153	177	204
150	194	243	—	—	—	—	—	—	—	—	—	—	—	71	89	106	125	145	166
Nominal cable weight ^{kg/M}		0.155	0.234	0.426	0.576	0.792	1.180	1.467	1.766	2.593	3.105	3.849	4.519	6.975	n.a.	n.a.	n.a.	n.a.	n.a.

¹ HP indicates rated horsepower obtained from motor nameplate.

² FLA (full-load amperes) obtained from NEC Table 430-150. Full-Load Current, Three Phase Alternating Current.

³ Cable length calculations are based on 125% motor full-load amperage (FLA), NEC Article 430-22 (A).

For special motors wired for Wye-Start, Delta-Run, the selection of conductors between the controller and the motor may be based on 58 percent of the motor full-load current [NEC 430.22 (C)]. It is recommended that the contractor/electrician contact Aeration Industries for recommended wiring sizing.

⁴ Kcmil indicates wire size in circular mils

⁵ Allowable Ampacities, obtained from NEC Table 310-16, Ampacities of Insulated Conductors - Copper Conductor at 75° C, "—" indicates inadequate Ampacity.

NOTE: Length calculations are based on resistance values obtained from NEC Table 9, AC Resistance and Reactance for 600 VAC Cables, 3 Phase, 60 Hz, 75° C (167° F). Typically the power cable is sized using the distance between the junction box on the shore and the motor, this being referred to as the "hard wire" connection. The power cable between the junction box and the controller is then sized separately using this new distance. This is especially critical where there is a great distance to a central control station and a heavier gage wire is required.

10.2 CABLE SELECTION BY VOLTAGE CHARTS

HP ¹	FLA ²	FLA ² x 125% ³	380 VAC 3Ø Voltage Drop ≤ 2% (Cable Length In Feet)																	
			#14	#12	#10	#8	#6	#4	#3	#2	#1	1/0	2/0	3/0	4/0	ml ⁴ 2	cm1 30	cm1 35	cm1 400	
<i>Allowable Ampacities</i> ⁵																				
1	2.3	2.9	20	25	35	50	65	85	100	115	130	150	175	200	230	255	285	310	335	
2	4	5.0	484	760	1267	1949	1784													
3	5.4	6.8	278	437	728	1121	1784													
5	8.9	11.1	206	324	540	830	1321	2088	2590											
7.5	12.2	15.3	125	196	327	504	802	1267	1571	2067										
10	16.1	20.1	91	143	239	367	585	924	1146	1508	1910	2388								
15	23.5	29.4	69	109	181	278	443	700	869	1143	1448	1810	2171							
20	32	40	—	74	124	191	304	480	595	783	992	1240	1488	1932	2399					
25	38	48	—	—	91	140	223	352	437	575	728	910	1093	1419	1762	2101	2483			
30	45	56	—	—	—	118	188	297	368	484	613	767	920	1195	1484	1769	2091	2421		
40	59	74	—	—	—	100	159	251	311	409	518	647	777	1009	1253	1494	1766	2044	2354	
50	71	89	—	—	—	121	191	297	371	484	613	767	920	1195	1484	1769	2091	2421		
60	85	106	—	—	—	—	—	159	197	259	328	410	492	639	794	947	1119	1296	1492	
75	100	125	—	—	—	—	—	—	165	216	274	343	411	534	663	791	935	1082	1246	
100	133	166	—	—	—	—	—	—	—	184	233	291	350	454	564	672	795	920	1059	
125	158	198	—	—	—	—	—	—	—	—	—	219	263	341	424	505	597	692	797	
150	194	243	—	—	—	—	—	—	—	—	—	—	221	287	357	426	503	582	671	
<i>Nominal cable weight</i> ^{LB/FT}			0.104	0.157	0.286	0.387	0.532	0.793	0.986	1.187	1.743	2.087	2.587	3.037	4.688	n.a.	n.a.	n.a.	n.a.	n.a.

¹ HP indicates rated horsepower obtained from motor nameplate.

² FLA (full-load amperes) obtained from NEC Table 430-150. Full-Load Current, Three Phase Alternating Current.

³ Cable length calculations are based on 125% motor full-load amperage (FLA), NEC Article 430-22 (A).

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⁴ Kcmil indicates wire size in circular mils

⁵ Allowable Ampacities, obtained from NEC Table 310-16, Ampacities of Insulated Conductors - Copper Conductor at 75° C, "—" indicates inadequate Ampacity.

NOTE: Length calculations are based on resistance values obtained from NEC Table 9, AC Resistance and Reactance for 600 VAC Cables, 3 Phase, 60 Hz, 75° C (167° F). Typically the power cable is sized using the distance between the junction box on the shore and the motor, this being referred to as the "hard wire" connection. The power cable between the junction box and the controller is then sized separately using this new distance. This is especially critical where there is a great distance to a central control station and a heavier gage wire is required.

HP ¹	FLA ²	FLA ² x 125% ³	# 14	# 12	# 10	# 8	# 6	Voltage Drop ≤ 2% (Cable Length In Feet)											
								# 4	# 3	# 2	# 1	1 / 0	2 / 0	3 / 0	4 / 0	ml ⁴ 2	cmil 30	cmil 35	cmil 400
Allowable Ampacities ⁵			20	25	35	50	65	85	100	115	130	150	175	200	230	255	285	310	335
1	1.7	2.1	793	1245	2075														
2	3.4	4.3	396	622	1037	1596	2540												
3	4.8	6.0	281	441	735	1130	1799												
5	7.6	9.5	177	278	464	714	1136	1796	2227										
7.5	11	13.8	123	192	321	493	785	1241	1539	2025	2565								
10	14	17.5	96	151	252	388	617	975	1209	1591	2015	2519							
15	21	26.3	—	101	168	258	411	650	806	1061	1343	1679	2015						
20	27	34	—	—	131	201	320	506	627	825	1045	1306	1567	2036	2528				
25	34	43	—	—	104	160	254	402	498	655	830	1037	1245	1617	2008	2394			
30	40	50	—	—	—	136	216	341	423	557	705	882	1058	1374	1706	2035	2405		
40	52	65	—	—	—	—	166	263	326	428	543	678	814	1057	1313	1565	1850	2142	2466
50	65	81	—	—	—	—	—	210	260	343	434	543	651	846	1050	1252	1480	1713	1973
60	77	96	—	—	—	—	—	177	220	289	366	458	550	714	886	1057	1249	1446	1665
75	96	120	—	—	—	—	—	—	176	232	294	367	441	573	711	848	1002	1160	1336
100	124	155	—	—	—	—	—	—	—	—	228	284	341	443	550	656	776	898	1034
125	156	195	—	—	—	—	—	—	—	—	—	—	—	352	438	522	617	714	822
150	180	225	—	—	—	—	—	—	—	—	—	—	—	305	379	452	534	619	712
Nominal cable weight ^{1B} / _{FT}			0.104	0.157	0.286	0.387	0.532	0.793	0.986	1.187	1.743	2.087	2.587	3.037	4.688	n.a.	n.a.	n.a.	n.a.

¹ HP indicates rated horsepower obtained from motor nameplate.

² FLA (full-load amperes) obtained from NEC Table 430-150. Full-Load Current, Three Phase Alternating Current.

³ Cable length calculations are based on 125% motor full-load amperage (FLA), NEC Article 430-22 (A).

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⁴ Kcmil indicates wire size in circular mils

⁵ Allowable Ampacities, obtained from NEC Table 310-16, Ampacities of Insulated Conductors - Copper Conductor at 75° C, "—" indicates inadequate Ampacity.

NOTE: Length calculations are based on resistance values obtained from NEC Table 9, AC Resistance and Reactance for 600 VAC Cables, 3 Phase, 60 Hz, 75° C (167° F). Typically the power cable is sized using the distance between the junction box on the shore and the motor, this being referred to as the "hard wire" connection. The power cable between the junction box and the controller is then sized separately using this new distance. This is especially critical where there is a great distance to a central control station and a heavier gage wire is required.

10.2 CABLE SELECTION BY VOLTAGE CHARTS

HP ¹	FLA ²	FLA ² x 125% ³	575 VAC 3Ø Voltage Drop ≤ 2% (Cable Length In Feet)																	
			#14	#12	#10	#8	#6	#4	#3	#2	#1	1/0	2/0	3/0	4/0	ml ⁴	2 cml	30 cml	35 cml	400
<i>Allowable Ampacities⁵</i>																				
1	1.4	1.8	20	25	35	50	65	85	100	115	130	150	175	200	230	255	285	310	335	
2	2.7	3.4	1203	1889	1633	2512														
3	3.9	4.9	624	980	1130	1739														
5	6.1	7.6	432	678	1130	1739														
7.5	9	11.3	276	434	723	1112	1770													
10	11	13.8	187	294	490	754	1200	1896	2351											
15	17	21.3	153	240	401	617	981	1551	1924	2531										
20	22	28	99	156	259	399	635	1004	1245	1638	2075	2593								
25	27	34	—	120	200	308	491	776	962	1266	1603	2004	2405							
30	32	40	—	—	163	251	400	632	784	1031	1306	1633	1959	2544						
40	41	51	—	—	138	212	337	533	661	870	1102	1378	1653	2147	2481					
50	52	65	—	—	—	165	263	416	516	679	860	1075	1290	1676	2081	2481				
60	62	78	—	—	—	—	208	328	407	535	678	848	1017	1321	1641	1956	2312			
75	77	96	—	—	—	—	174	275	341	449	569	711	853	1108	1376	1641	1939	2245	2586	
100	99	124	—	—	—	—	—	222	275	362	458	573	687	892	1108	1321	1561	1808	2082	
125	125	156	—	—	—	—	—	—	214	281	356	445	534	694	862	1028	1214	1406	1619	
150	144	180	—	—	—	—	—	—	—	—	282	353	423	550	683	814	962	1114	1282	
<i>Nominal cable weight^{LB/FT}</i>			0.104	0.157	0.286	0.387	0.532	0.793	0.986	1.187	1.743	2.087	2.587	3.037	4.688	n.a.	n.a.	n.a.	n.a.	n.a.

¹ HP indicates rated horsepower obtained from motor nameplate.

² FLA (full-load amperes) obtained from NEC Table 430-150. Full-Load Current, Three Phase Alternating Current.

³ Cable length calculations are based on 125% motor full-load amperage (FLA), NEC Article 430-22 (A).

For special motors wired for Wye-Start, Delta-Run, the selection of conductors between the controller and the motor may be based on 58 percent of the motor full-load current [NEC 430.22 (C)]. It is recommended that the contractor/electrician contact Aeration Industries for recommended wiring sizing.

⁴ Kcmil indicates wire size in circular mils

⁵ Allowable Ampacities, obtained from NEC Table 310-16, Ampacities of Insulated Conductors - Copper Conductor at 75° C, "—" indicates inadequate Ampacity. **NOTE:** Length calculations are based on resistance values obtained from NEC Table 9, AC Resistance and Reactance for 600 VAC Cables, 3 Phase, 60 Hz, 75° C (167° F). Typically the power cable is sized using the distance between the junction box on the shore and the motor, this being referred to as the "hard wire" connection. The power cable between the junction box and the controller is then sized separately using this new distance. This is especially critical where there is a great distance to a central control station and a heavier gage wire is required.

11.2 PARTS ORDER FORM

Parts Orders:

The following information is important to assure that when you order spare or emergency parts that the correct part has been defined. Being prepared with the proper information when placing your order will expedite your order process and assure you receive the correct part (s). **Some Part numbers will be determined at Aeration Industries international Inc., based upon Product Information and Description Provided.**

Aeration Industries International, Inc.
4100 Peavey Road
Chaska, Minnesota 55318 USA
Attention: Customer Service

Telephone: 1-952-448-6789
Facsimile: 1-952-448-7293
Customer Service Hotline: 1-800-328-8287
E-mail: aiii@aireo2.com

Your Purchase Order #: _____ Page _____ of _____
All Customer # _____
Your Phone # _____ Fax # _____
E-Mail # _____
Original Product Purchase Information
Product Name: _____ HP: _____ HZ: _____
Assembly Part #: _____ Serial #: _____ Purchase Date: _____
Original Purchase Sales Order #: _____

Shipping Address if Different from your billing address:

Company Name: Line 1 _____
Line 2 _____
Line 3 _____

Company Address: Line 1 _____
Line 2 _____
Line 3 _____

City _____ State _____ Country _____ Zip Code _____
Ship to the Attention of: _____ Phone/Ext # _____
Shipping Preference _____
Urgency: _____

Parts Needed:

ITEM #	Part #	Description	Quantity
1.	_____	_____	_____
2.	_____	_____	_____
3.	_____	_____	_____
4.	_____	_____	_____
5.	_____	_____	_____
6.	_____	_____	_____
7.	_____	_____	_____

Attach additional copies of this form if more than 7 different parts are needed.

Storage

In case of outdoor storage, the motor must be covered with plastic without sealing it. Otherwise, condensation will occur, which can cause motor damage.

If the units are left in the water, put a plastic cover securely over the motor without sealing it.

To prevent condensation on the windings when the motors are stopped for a long time, motor space heaters are required.

Storage Conditions**Short Term**

The following storage requirements must be followed:

1. Motors are to be kept in their original containers or provided with equivalent protection and stored in a warehouse free from extremes in temperature, humidity, and corrosive atmosphere.
2. If unusual vibrations exist at the storage location, the motor should be protected with isolation pads.
3. All breathers and drains are to be operable while in storage and/or the moisture drain plugs removed. The motors must be stored so the drain is at the lowest point.

Storage Preparation

Improper storage of electric machines will result in seriously reduced reliability of that equipment. For example, an electric motor that does not experience regular usage while being exposed to normally humid atmospheric conditions is likely to cause the bearings to rust or rust particles from surrounding surfaces to contaminate the bearings. The electrical insulation may absorb an excessive amount of moisture leading to the motor winding failing to ground. The following preparations should be followed:

1. Minimize condensation in and around the motor by use of desiccants or other humidity control methods.
2. Motor space heaters when specified are to be energized where there is a possibility that the storage ambient conditions will reach dew point. Space heaters are an option.
3. Coat all external machined surfaces with a material to prevent corrosion. An acceptable product for this purpose is Exxon Rust Ban #392.
4. Measure and record the electrical resistance of the winding insulation with a megger or an insulation resistance meter. Minimum accepted Megohm Level is the insulation kV rating +1 Megohm. If levels fall below the above, contact the nearest Reliance sales office. The recorded data will be required when removing from storage.
5. Some motors have a shipping brace attached to the shaft to prevent damage during transportation. The shipping brace, if provided, must be removed and stored for future use. The brace must be reinstalled to hold shaft firmly in place against the bearing before the motor is moved.

6. Upon placing the motor into extended storage (greater than 3 months), the motors with greaseable bearings must be greased per Table 1 followed by the motor shaft being rotated a minimum of 15 times after greasing. Non-greaseable motors with “Do not Lubricate” nameplates should also be rotated 15 times to redistribute grease within bearing.
7. Motor shafts are to be rotated manually every 6 months and additional grease added purging some of that cavity. Grease in the bearings is to be purged at the time of removal from storage, making sure that an ample supply of fresh grease is in each grease cavity.
8. Remove the grease drain plug, if supplied, (opposite the grease fitting) on bottom of each end bracket prior to lubricating the motor.) Replace the plug after greasing.

Non-greaseable motors should have their shaft rotated 15 revolutions every 3 months.

9. All breather drains should be fully operable while in storage. The motors must be stored so the drain is at the lowest point. All breathers and automatic “T” drains must be operable to allow breathing at points other than through the bearing fits.
10. The space heaters when specified are to be connected and operable while in storage.
11. Windings are to be meggered at the time equipment is put in storage. At the time of removal from storage, the insulation resistance reading must not have dropped more than 50% from the initial reading. Any drop below this point necessitates electrical or mechanical drying. Refer to “Motor Drying Procedure.”
12. Where motors are not stored in the original containers, but are removed and mounted on other pieces of machinery, the mounting must be such that the drains and breathers and space heaters are fully operable. In this respect, the drains must be kept at the lowest point in the motor so that all condensation can automatically drain out.

For Storage of Extended Periods of Time Greater than 18 months

All requirements of general preparation and short term storage apply with the following additional requirements.

1. Motor is to be crated in a box similar to EXPORT BOXING but that the “shell” (sides & top of box) will be LAG- BOLTED to the wooden base (not nailed as export boxes are). This design will allow for the opening and re-closing the box many times without destroying the “shell”.
2. The motor will be sealed in an airtight vapor barrier bag with desiccant inside. This airtight bag will give added protection during shipment of motor to the permanent storage area.
3. After the first “Inspection” for megger reading, turning the shaft, etc., the vapor bag should be re-sealed by taping it closed with masking or similar tape. Also add new desiccant inside bag before closing. The shell should then be placed over the motor and the lag bolts replaced.

12.0 STORAGE PROCEDURES

STS 01 64 00 ATTACHMENT 1

4. If a “zipper-closing” type bag is used instead of the “heated-sealed” type bag, then re-zipper the bag closed Instead of taping it.
5. Be sure to add new desiccant inside bag after each periodic inspection.
6. Minimize the accumulation of condensed water in and around the machine.

Lubrication Volume (Storage)	
NEMA Frame Size (IEC)	Vol. in Cubic In. (Cm³)
182 thru 215 (112–132)	0.5 (8)
254 thru 286 (160–180)	1.0 (16)
324 thru 365 (200–225)	1.5 (24)
404 thru 449 (250–280)	2.5 (40)

13.0 WARRANTY

With proper use, installation, and maintenance, Aeration Industries International, Inc., warrants that it will, at its option, replace goods found to be defective in material or workmanship for a period of up to 36 months from date of shipment, providing the purchaser gives written notice of such defect to the manufacturer. This warranty specifically excludes labor charges that may be incurred. It is also stipulated in this warranty that the purchaser shall return the goods, if requested, to the manufacturer at the point of origin, with transportation charges prepaid by the purchaser. If an examination by the manufacturer discloses to its satisfaction the existence of such defect, the manufacturer will honor this warranty. In no event shall the manufacturer be liable for any incidental, special, or consequential damages resulting from said defects.

13.1 WARRANTY COVERAGE

When the AIRE-O₂[®] AERATOR is put into service, follow the warranty validation procedure previously sent by registered mail after start-up. These sheets request data on parties involved with installation and motor warranty validation information. Complete and return these sheets to Aeration Industries International, Inc. Failure to complete the warranty information will result in Non-issuance of the factory warranty. Locate "Maintenance and Service Record" page 52. Customer Service may request completed forms as evidence of proper AIRE-O₂[®] AERATOR maintenance. **Complete and file Maintenance and Service Record Sheets.**

CAUTION: (Exclusions to Warranty)

- **The sleeve and bearing located just above the propeller are water lubricated. If the unit is allowed to run dry, bearing damage will occur. This condition is not covered under terms of our warranty.**
- **Never use an AIRE-O₂[®] AERATOR in a basin where a foam-layer covers the motor either partly or completely. Defects resulting from such situations will not be covered by the warranty.**

13.2 RETURN-AUTHORIZATION POLICY

Prior to returning any parts, call Customer Service Hot-Line **(1-800-328-8287)**, to discuss the reason for return and obtain an authorization for the return. A Returned Materials Authorization (RMA) number will be issued by the representative if returned parts will be accepted. This number should be referenced on the shipping label(s) of the material being returned to ensure that the Receiving Department will accept the shipment.

NOTE: A copy of the Maintenance and Service Record sheet for the applicable AIRE-O₂[®] AERATOR must be returned with the part. No parts will be accepted without the RMA number indicated on the shipping label.

13.3 CREDITING / DEBITING YOUR ACCOUNT

Warranty replacement parts will be debited to your account. Parts returned under a Returned Materials Authorization (RMA) number will be credited to your account after receipt at our facility addressed below.

**Aeration Industries Int. Inc.
4100 Peavey Road
Chaska, Minnesota 55318
Ref: RMA Number**

14.0 SERVICE ADDENDUM

14.1 AIRE-O₂® AERATOR DISASSEMBLY AND REASSEMBLY

DANGER: Turn off electrical power and lock the aerator “Out of Service “ before working on the aerator. A hoist will be needed if the motor will be replaced. Otherwise servicing and repairs can be preformed after tipping the unit up raising the propeller above the water. Lock in place using bolts.

Propeller and Diffuser Disassembly: (Ref: Drawing on page 80)

1. Slip a large screwdriver through the air intake hole in the housing and into the shaft universal joint, to prevent the shaft from turning. Take care not to damage the grease zerk in the universal joint.
2. Using a wrench, loosen the diffuser, screw the diffuser off in a counter clockwise direction.
3. To remove the propeller tap the propeller with the rubber mallet and unscrew the propeller in a counterclockwise direction.

CAUTION: Always wear gloves when handling the propeller. Blade edges may be sharp.

Housing Disassembly:

Remove the housing by unscrewing the four cap screws attaching the housing to the motor mounting flange. Slide or pry the housing off the shaft.

NOTE: The sleeve may remain in the bearing and come off with the housing. Take care not to drop the sleeve as it may shatter.

Sleeve Removal:

Slip the sleeve and the two nylon washers off the shaft. Remember, the sleeve will crack or shatter if dropped.

Shaft Disassembly:

Loosen the two Universal joint set screws holding the aerator shaft to the motor shaft. Slide the aerator shaft off the motor shaft. Remove the key. Aerator parts can be serviced if needed.

Bearing Removal:

The bearing can be removed from the housing by pressing' it all the way through from the propeller end, letting it fall out the flange end of the housing. Scrape off any bearing residue that may stick to the housing bore.

Another method is to hammer a screwdriver along the inside diameter of the bearing. Once the black elastomeric portion of the bearing has been split, wedge the screwdriver between the fiber backing and the housing bore at the point of split. The bearing will crack and can be peeled out. Scrape off any bearing residue that may stick to the housing bore.

Bearing Assembly:

1. Stand the shaft housing vertically, with flange end down, and insert a new bearing into the prop end of the housing. Place a fiat protective plate over the outside face of the bearing. Press or pound on the protective plate until the bearing is installed flush with the face of the housing.
2. Using the three existing holes located in the propeller end of the housing as guides, match drill holes completely through the bearing. Remove any material shreds remaining around the newly drilled holes. Use a sharp knife to do this trimming. Bevel the internal opening. Cut away bearing burrs or shreds to smooth opening.

Mounting Flange And Shaft Assembly:

1. If the mounting flange has been removed, reattach the mounting flange to the motor using four cap screws and washers. Viewing the motor from the shaft end, with the electrical junction box at 12 o'clock, orient the pins on the mounting flange in the 9 and 3 o'clock positions.
2. Insert the key into the motor shaft and coat the shaft, key way, and the key liberally with anti-seize compound.
3. Slide the aerator shaft Universal joint onto the motor shaft until it contacts the shaft shoulder. It may require tapping with a rubber hammer.
4. Apply anti-seize compound to the two Universal joint setscrews. Tighten the setscrew over the key first to ensure proper balance of the shaft. Tighten the remaining set screw.

Housing Assembly:

1. Slip the shaft housing, flange end first, over the aerator shaft, bolt it to the motor mounting flange. Use four cap screws and lock washers.

NOTE: The air intake hole should be in the up position, in line with the motor electrical box.

Sleeve Assembly:

1. Slide a nylon washer onto the aerator shaft. Apply a grease lubricant to the outer surface of the sleeve, and slide the sleeve over the protruding shaft end. Insert the sleeve through the housing bearing until it contacts the shaft shoulder.
2. Slide the remaining nylon washer onto the shaft into place against the sleeve.

Propeller And Diffuser Assembly:

1. Insert a large screwdriver through the air intake hole in the housing and into the shaft Universal joint to prevent the shaft from turning. Do not damage the grease zerk in the Universal joint.
2. Inspect the propeller inside bore and threads. Inspect the shaft area protruding from the housing, and the threads. Remove dirt or debris.
3. Liberally apply anti-seize compound to the entire shaft area protruding from the housing including the threads and slide the propeller onto the shaft.

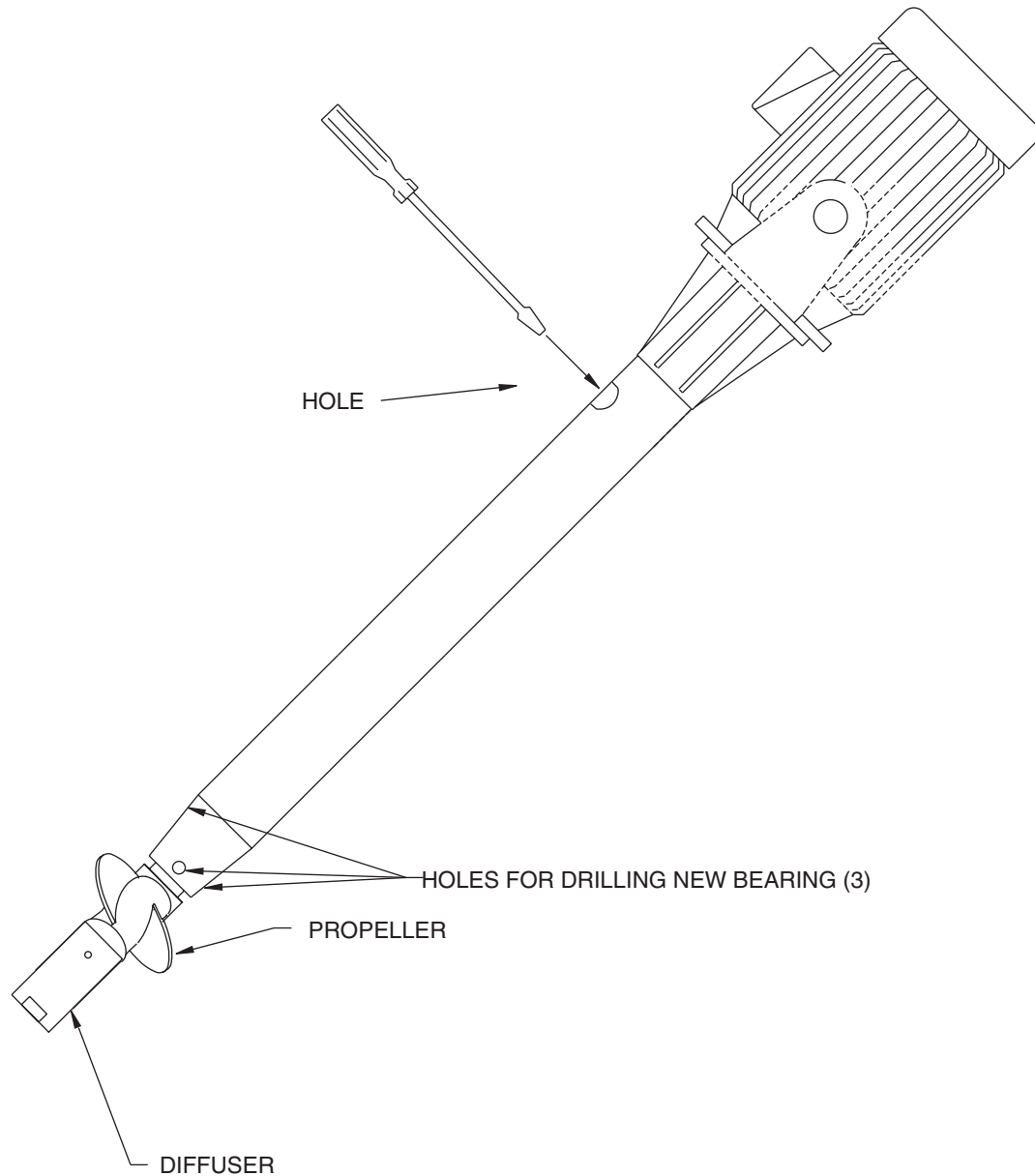
14.1 AIREO₂[®] AERATOR DISASSEMBLY AND REASSEMBLY

CAUTION: Always wear gloves when handling the propeller. Blade edges may be sharp.

- 4. Using the force of one hand only, turn the propeller in the clockwise direction until firmly seated against the nylon washer and sleeve. **DO NOT FORCE.** If any resistance is encountered, back the propeller off and inspect for dirt, debris, impurities, nick, etc. You may wish to “bump” the propeller with a rubber mallet to give final tightening
- 5. Thread the diffuser onto the shaft end and rotate clockwise until firmly seated against the propeller. The aerator reassembly is now complete.

WARNING! WARNING!

Remember! Remove the screwdriver from the air intake hole.



ELEV



Aeration Industries International, Inc.

4100 Peavey Road
Chaska, Minnesota 55318 USA

Telephone: 1-952-448-6789

Facsimile: 1-952-448-7293

Customer Service Hotline: 1-800-328-8287 (inside the U.S.A)

E-mail: aiai@aireo2.com

Web Site: <http://www.aireo2.com>

SUPPLEMENTAL SECTION 01 71 33

WORK SEQUENCE

PART 1: GENERAL

1.0 RELATED WORK

- A. General and Supplemental General Conditions of the Contract and Division 1

2.0 GENERAL REQUIREMENTS

- A. All new work may be scheduled simultaneously, but must be done under the requirements herein.
- B. The CONTRACTOR shall submit and maintain construction progress schedules pursuant to the GENERAL CONDITIONS of the contract.
- C. The CONTRACTOR's proposed progress schedule shall reflect all coordination efforts of the work of this contract. The progress schedule shall identify points in time when any utility service (sewer, water, gas, electric, etc.) shutdowns shall need to occur, and the duration of those shutdowns. Regardless of shutdowns, CONTRACTOR remains responsible for by-pass pumping on incoming wastewater at all times throughout the contract duration.
- D. The CONTRACTOR shall modify the progress schedule as required, prior to the start of construction, to eliminate potential conflicts, delays, and disruption of utility service activities to the satisfaction of the ENGINEER and the WWTP personnel.
- E. CONTRACTOR shall get written approval from the ENGINEER and WWTP personnel on final sequence of work and any modification to the schedule during construction.
- F. The CONTRACTOR shall perform the work complete, in place, and ready for continuous service, and shall include repairs, testing, permits, cleanup, replacements, and restoration required as a result of damages caused during this construction.
- G. All Work is to be performed in accordance with this Section and with Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), Department of Transportation (DOT), National Institute of Occupational Safety and Health (NIOSH), and other state, tribal and local regulations.

3.0 REFERENCES AND DEFINITIONS

- A. Where all or part of a Federal, ASTM, ANSI, AWWA, and Arizona Uniform Standard Specification for Public Works Construction etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.
- B. Definitions:

1. Progress Schedule—A schedule, prepared and maintained by CONTRACTOR, describing the sequence and duration of the activities comprising the CONTRACTOR's plan to accomplish the work within the contract Times.
2. Shut Down – component/equipment/system is not in active service.
3. Start Up – a new component/equipment/system is placed back into service per the specifications.
4. Restart – an existing component/equipment/system is placed back into service per the specifications.

4.0 SUBMITTALS

- A. General: Submit listed submittals in accordance with conditions of the Contract and with Specification 01 33 00.
- B. Schedule: submit and maintain construction schedules pursuant to the GENERAL CONDITIONS of the contract.
- C. The CONTRACTOR shall submit for the ENGINEER'S approval a written by-pass pumping plan with the initial construction progress schedule. The plan shall contain a contingency plan in the event of pump(s) failure, the sequence of construction and a list of all piping, pumps, plugs, etc., required for this project.

5.0 SPECIAL CONSIDERATIONS

- A. Treatment of wastewater cannot be interrupted. Flow through the plant and electrical power to all the equipment shall be maintained at all times.
- B. Under no circumstances will the CONTRACTOR be permitted to divert or discharge any untreated or partially treated wastewater from the WWTP unless preapproved in writing by the ENGINEER and OWNER.
- C. The CONTRACTOR shall also coordinate his/her activities with the other CONTRACTORS on site to allow orderly and timely completion of all the work. Other projects that may be occurring at the same time as this project are as follows: None.
- D. Interconnections within the plant may depend on the closure of valves and gates. The CONTRACTOR shall coordinate with the ENGINEER and the WWTP personnel prior to attempting any such closure.
- E. The CONTRACTOR shall not operate any of the valves or gates. The CONTRACTOR shall coordinate with the OWNER so that WWTP personnel will close or open the necessary valves and gates at the plant after adequate and proper preparation time.
- F. Various interconnections within the plant may require temporary partial power shutdown. The CONTRACTOR shall make every effort necessary to minimize the shutdown time and shall coordinate with the ENGINEER and the WWTP personnel and/or utility company prior to attempting any such power shutdown.

- G. The CONTRACTOR shall provide any corrective measure or temporary facilities necessary to attain the shut-off needed (sewer, water, gas, electric, etc.) to perform the work at no additional cost to the OWNER and without interrupting the plant operation.
- H. Conversion from existing facilities to new facilities will be coordinated with the CONTRACTOR and the WWTP personnel. Best conversion times may be between 10 p.m. and 6 a.m. during low flow periods.
- I. When the work requires an existing facility to be taken out of operation (shutdown), temporarily or permanently, the CONTRACTOR shall notify the ENGINEER and WWTP personnel in writing a minimum of 10 calendar days in advance. The shutdown may not begin until approval has been granted in writing by the OWNER and the ENGINEER.

6.0 CONSTRUCTION SCHEDULES

- A. A detailed schedule shall be submitted, beginning with Notice to Proceed through Final Completion.
- B. Show activities including, but not limited to the following:
 - 1. Notice to Proceed.
 - 2. Permits.
 - 3. Submittals, with review time.
 - 4. Early procurement activities for long lead equipment and materials.
 - 5. Initial site work.
 - 6. Earthwork.
 - 7. Specified Work sequences and construction constraints.
 - 8. Contract Milestone and Completion Dates.
 - 9. Major structural, mechanical, equipment, electrical, architectural, and instrumentation and control Work.
 - 10. System startup summary.
 - 11. Project close-out summary.
 - 12. Demobilization summary.

7.0 TEMPORARY EQUIPMENT

- A. Provide temporary power when necessary to keep plant functioning properly. The flows for the plant are indicated in the drawings. When necessary, when de-energizing equipment for replacement, demolition, or switchover to new electrical service.
- B. Provide temporary piping and pumping equipment, when necessary, to keep plant functioning properly. The flows for the plant are indicated in the drawings.
- C. Lay temporary piping above ground and protect as necessary from equipment traffic and freezing.
- D. If temporary by-pass pumping is used, the CONTRACTOR shall use a grinder pump which reduces the size of solids to less than 1-inch in diameter or provide screening of the wastewater so that no solids larger than 1-inch enters the lagoon system.

- E. The CONTRACTOR shall submit for the ENGINEER'S approval (7 copies) a written by-pass pumping plan with the initial construction progress schedule. The plan shall contain a contingency plan in the event of pump(s) failure, the sequence of construction and a list of all piping, pumps, plugs, etc., required for this project.
- F. All piping, joints and accessories used for by-pass pumping shall be designed to withstand at least twice the maximum system pressure or a minimum of 50 psi whichever is greater.
- G. The CONTRACTOR shall test pump each section of pipe to be by-passed prior to beginning any construction. The test shall demonstrate to the OWNER'S satisfaction that all equipment is operable and capable of safely conveying all flows
- H. During by-pass pumping, sewage shall not be leaked, dumped, or spilled in or onto, any area outside of the existing sanitary sewer pipe system.
- I. When by-pass pumping operations are complete all piping shall be drained from the pipe prior to disassembly.
- J. Any and all overflows shall be immediately reported to the OWNER and the ENGINEER by the CONTRACTOR. Any fines associated with the overflows shall be promptly paid by the CONTRACTOR.
- K. Contractor shall provide temporary electrical facilities as required during the time that associated electrical equipment is being installed. At no time can the plant and supporting facilities be without full operating power. Contractor shall coordinate closely with the Owner and power company all activities related to the proposed improvements and incoming electrical power system.
- L. CONTRACTOR'S FIELD OFFICE
 - 1. The contractor's field office, if the contractor chooses to have a field office, shall be located within 100 ft from the existing electrical service. The field office is not necessary and no additional payment will be made. If the contractor chooses to have a field office for this project, the remainder of section 1 C applies.
 - 2. Provide a heated and air conditioned temporary field office(s) for the CONTRACTORS use for the duration of the project. An authorized representative of the CONTRACTOR shall be present at all times while the Work is in progress. Instructions received at the CONTRACTORS field office from the ENGINEER shall be considered delivered to the CONTRACTOR.
 - 3. Provide a work area to include a desk, a chair, lighting and a power outlet for use by the ENGINEER within field office.
 - 4. Establish and occupy field office within 30 days of the Notice to Proceed, unless otherwise approved by the ENGINEER or OWNER.
 - 5. Provide a minimum of one (1) temporary, self-contained, single occupant toilet units of the chemical, aerated recirculation, or combustion type, properly vented and fully enclosed in a

fiberglass or other approved non-absorbent shell. Maintain daily in a clean and sanitary condition.

M. TEMPORARY POWER, LIGHT AND COMMUNICATION

1. The CONTRACTOR shall furnish temporary light and power complete with wiring, lamps and similar equipment as required to adequately light all work areas and with sufficient power capacity to meet the project needs. Make all necessary arrangements with the local electric company (NTUA) for temporary electric service and pay all expenses in connection therewith.
2. The CONTRACTOR shall furnish any temporary communication requirements (phone, facsimile, internet, email, etc.) the CONTRACTOR may need for completion of the project. Make all necessary arrangements with the local communication company for temporary communication services and pay all expenses in connection therewith.
3. Temporary facilities shall be removed for Substantial Completion and final completion. Clean and repair any damages caused by the installation or use of the temporary work.

N. TEMPORARY WATER

1. Provide and maintain suitable quality water service for construction operations at the time of project mobilization.
2. Connect to the existing water source.
 - i. Exercise measure to conserve water.
 - ii. Provide separate metering and pay all fees associated with water use to the water utility company.
 - iii. For all exposed temporary piping, provide insulation and freeze protection.

8.0 OWNER OCCUPANCY

- A. The OWNER shall have full access to and use of all existing utilities during the entire period of construction for the conduct of their normal operations.
- B. CONTRACTOR shall at all times conduct their operations as to insure the least inconvenience to the general public and plant operating/maintenance personnel.
- C. All operations of existing facilities shall be performed by WWTP personnel, coordinated through the OWNER and ENGINEER by the CONTRACTOR.
- D. When access through construction areas must be disrupted, the CONTRACTOR shall provide alternate acceptable access for the plant operators or other CONTRACTORS. A written plan of alternative access shall be presented to ENGINEER at least 10 days prior to disturbance.
- E. The CONTRACTOR shall provide adequate storage areas for materials and equipment during the course of the work. The CONTRACTOR shall make arrangements for securing and maintaining

storage areas during construction and be fully responsible those areas while in use, regardless of ownership.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED.

END OF SECTION

SUPPLEMENTAL SECTION 01 73 19

INSTALLATION OF WASTEWATER TREATMENT FACILITY EQUIPMENT

PART 1: GENERAL

1.0 WORK INCLUDED

- A. General methods and procedures in prosecuting, handling erecting and placing in service wastewater treatment facility equipment.

2.0 RELATED WORK

- A. General and Supplemental General Conditions of the Contract and Division 1
- B. Section 01 77 23: Operating and Maintenance Data
- C. Section 46 51 13.1: Tuba City Waste Water Treatment Plant
- D. Section 46 51 13.2: Pinon Waste Water Treatment Plant
- E. Section 46 51 13.3: Kayenta Waste Water Treatment Plant
- F. Section 46 51 13.4: Ganado Waste Water Treatment Plant
- G. Section 46 51 13.5: Chinle Waste Water Treatment Plant
- H. Division 16: Electrical

3.0 SUBMITTALS

- A. General: Submit listed submittals in accordance with conditions of the Contract and with Specification 01 33 00.
- B. Submit name and resume of proposed field services technicians at least 30 days in advance of start-up of equipment.
- C. Submit detailed testing plans and procedures for field performance tests and final acceptance tests as specified in the various equipment sections.
- D. Submittals shall include the following:
 - 1. Test plans/procedures shall be submitted at least 30 days in advance of the proposed test dates and shall include at least the following information:
 - a) Name of equipment to be tested, including reference to specifications section number and title.
 - b) Testing schedule of proposed dates and times for testing.

- c) Summary of power, lighting, chemical, water, sludge, gas, etc, needs and identification of who will provide them.
 - d) Outline specific assignment of the responsibilities of the Contractor and manufacturers' factory representatives or field service personnel.
2. Detailed description of step-by-step testing requirements, with reference to appropriate standardized testing procedures and laboratory analyses by established technical organizations (e.g., ASTM, WPCF Standard Methods, etc).
 3. Samples of forms to be used to collect and record test data and to present tabulated test results.
 4. Copies of the manufacturer's field service technician's report summarizing the results of his/her initial inspection, operation, adjustment, and pre-tests. The report shall include detailed descriptions and tabulations of the points inspected, tests and adjustments made, quantitative results obtained, suggestions for precautions to be taken to ensure proper maintenance, and the equipment supplier's Certificate of Installation in the format specified herein.

4.0 QUALITY ASSURANCE

- A. The services of qualified and experienced technical representatives of respective equipment manufacturers as specified in the Technical Specifications shall be furnished.
- B. Such representatives shall be present at the project to assist in erection and installation procedures requiring detailed knowledge of the work.
- C. The representative is to be present to inspect for proper installation, making adjustments, and instruction of plant personnel in operation and maintenance of equipment.

PART 2: PRODUCTS

- A. As specified under these Specifications or as shown on the Plans.

PART 3: EXECUTION

1.0 DELIVERY AND INSTALLATION

- A. The manufacturers shall provide written instructions to the CONTRACTOR that details the installation procedures for all supplied equipment (Goods) including associated ancillary components. Installation instructions include any requirements prescribed by the manufacturers or their suppliers for the proper unloading, handling, assembly, placement, connection, or wiring of the Goods.
- B. A representative of each manufacturer shall provide visit(s) necessary to verify the proper installation and operation of the Goods.

- C. The CONTRACTOR shall be responsible for making any adjustments and / or modifications to the installation process that may become necessary to ensure that all equipment is properly installed.
- D. After the installation of the System is complete, the CONTRACTOR and ENGINEER shall jointly inspect the Systems and list any equipment that has not been properly installed, detailing the outstanding installation issues on a "punch list" and noting the party who shall be responsible for each correction.

2.0 MANUFACTURERS' ON-SITE SERVICE

- A. A factory-trained service ENGINEER or technician shall be present to check installation and operation.
- B. A report certifying that the equipment has been installed and is operating correctly shall be provided by the service representative; the Certificate of Proper Installation (see Attachment 1) shall be submitted.
- C. See individual equipment specifications for manufacturers' on-site service schedule requirements.

3.0 START-UP SERVICES

- A. The Manufacturer shall be responsible for providing labor, materials, equipment, and incidentals necessary to perform and coordinate the start-up of the equipment.
- B. Unless otherwise allowed by the OWNER, the Manufacturer shall not plan for start-up to be allowed except during normal business or construction hours, 5 days per week, 8 hours per day.
- C. The Manufacturer shall be responsible for providing a detailed start-up schedule for all tasks associated with the startup and commissioning of the equipment. The schedule shall be submitted a minimum of 30 days prior to the start-up date and shall be updated as often as necessary or requested to ensure appropriate coordination with the OWNER and installation CONTRACTOR.
- D. A Start-up Planning site meeting shall be scheduled 5 business days prior to start-up to discuss the following:
 - 1. Review start-up sequence and activities.
 - 2. Discuss responsibilities of all personnel and involved parties.
 - 3. List persons to be present during start-up.
 - 4. List persons to remain on-call during start-up
 - 5. Discuss Emergency Action Procedure.

- E. The Manufacturer shall be responsible for initial operation of the control system and shall make any required changes, adjustment or replacements for operation, monitoring, and control of the various processes and equipment necessary to perform the functions intended.
- F. The Manufacturer shall perform checkout and start-up of system components that are supplied by the manufacturer. As part of these services, the Manufacturer shall include for those equipment items not manufactured by him, the services of an authorized manufacturer's representative to check the equipment installation and place the equipment in operation or provide letters from manufacturers authorizing the System Manufacturer to put equipment in operation.
- G. No system or subsystem shall be started-up for continuous operation unless all Goods, including instrumentation and monitoring systems, of that system or subsystem have been tested and proven to be operable as intended by the Specifications.
- H. Manufacturer shall provide one set of start-up documentation for the System for the OWNER'S personnel, one set for the ENGINEER'S use, one set for field use, and the required number of sets for the Manufacturer's use.
 - 1. Manufacturer shall provide the following documentation for use during the start-up effort.
 - a) Panel schematic and internal point-to-point wiring interconnect drawings.
 - b) Panel layout drawings
 - c) Field wiring diagrams
 - d) Instrument loop diagrams
 - e) Calibration certificates for field and panel devices that require adjustment or calibration.
 - 2. The drawings corrected and modified during start-up shall form the basis for the "As-Built" record drawing requirement, see Specification 01 78 39.
- I. Pre-Start-Up Activities
 - 1. The guidelines shall include the following minimum check items
 - a) Wiring shall be checked at each termination point for correct wire size, type, color, termination and wire number.
 - 2. Control System shall be checked for the following items:
 - a) Control Panels.

3. Pump(s), Blowers, and Mixers (if applicable) shall be checked to ensure that the equipment is:

- a) Filled with oil
- b) Rotation is proper
- c) Aligned properly (mechanical seal has been set)
- d) Receives and responds to process control command signals (discrete and/or analog)

J. The Manufacturer shall coordinate all commissioning activities with the installation CONTRACTOR, OWNER and ENGINEER. The types of activities to be performed by the Manufacturer will include but not necessarily limited to the following items:

1. Initial Start-Up Activities

- a) Verify unit and piping installation
- b) Verify valve tags
- c) Verify system interconnections

2. Start-Up Activities

- a) Verify motors for rotation
- b) Set mechanical seals
- c) Check start-up and shut down sequence in normal and emergency modes

K. Upon completion of the commissioning by the Manufacturer, the ENGINEER shall review the operation of the equipment to verify that the start-up is complete. The ENGINEER shall perform random tests to determine if the equipment is operating properly and witness various operational sequences. The ENGINEER may initiate alarm conditions to determine if the control system is functioning properly.

4.0 TRAINING OF OPERATIONS AND MAINTENANCE PERSONEL

A. The Manufacturer shall provide the services of factory-trained specialists to instruct the OWNER'S personnel in the recommended operation and the preventive maintenance procedures for all System equipment provided.

B. The Manufacturer shall allow any and all training sessions to be videotaped by the OWNER. All training material shall be provided to the OWNER in electronic format.

C. Instruction of the OWNER'S personnel shall commence within five days after the equipment has been started unless otherwise stated in specifications, preliminary operation and maintenance

manuals have been turned over to the OWNER, and commissioning has been completed. The Certificate of Instruction (See Attachment 3) shall be submitted at the conclusion of training for each system.

- D. The System Manufacturer shall retain the services of component equipment suppliers' representative(s) for training on their own equipment, as necessary.
- E. Coordination: The Manufacturer shall coordinate these services at times acceptable to the ENGINEER, with a minimum of seven (7) days prior notice
- F. Training: The training shall include the following as a minimum:
 - 1. Equipment Operation:
 - a) Describe equipment's operating (process) function.
 - b) Describe equipment's fundamental operating principals and dynamics.
 - c) Identify equipment's mechanical, electrical, and electronic components and features.
 - d) Identify all support equipment associated with the operation of subject equipment (e.g., compressed air intake filters, valve actuators, motors).
 - e) Recommend standard operating procedures to address start-up, routine monitoring, and shutdown of the equipment.
 - 2. Detailed Component Description:
 - a) Identify and describe in detail each component's function.
 - b) Group related components into subsystems, where applicable. Describe subsystem functions and their interaction with other subsystems.
 - c) Identify and describe in detail equipment safeties and control interlocks.
 - 3. Equipment Preventive Maintenance (PM):
 - a) Describe PM inspection procedures required to:
 - i. Perform an inspection of the equipment in operation.
 - ii. Spot potential trouble symptoms and anticipate breakdowns.
 - iii. Forecast maintenance requirements (predictive maintenance).
 - b) Define the recommended PM intervals for each component.
 - c) Provide lubricant and replacement part recommendations and limitations.

- d) Describe appropriate cleaning practices and recommend intervals.
 - e) Identify and describe the use of special tools required for maintenance of the equipment.
 - f) Describe component removal / installation and disassembly/assembly procedures.
 - g) Perform at least two "hands-on" demonstrations of preventive maintenance procedures.
 - h) Define recommended torquing, mounting, calibration, alignment procedures and settings, as appropriate.
 - i) Describe recommended procedures to check/test equipment following a corrective repair.
4. Equipment Troubleshooting:
- a) Define recommended systematic troubleshooting procedures,
 - b) Provide component specific troubleshooting checklists.
 - c) Describe applicable equipment testing and diagnostic procedures to facilitate troubleshooting.

5.0 ACCEPTANCE TESTING

A. Equipment Check-Out:

1. Perform initial check-out and adjustment to insure that everything is in working order as soon as equipment is erected and lubricated.
2. Protect all parts as necessary to prevent corrosion or deterioration until final painting.

B. Testing and Placing in Service:

1. Complete all preliminary check-out and testing operations and make necessary adjustments.
2. Obtain approval from the ENGINEER before placing equipment in the lagoons.
3. Place equipment in service, furnishing necessary personnel qualified to operate plant.

C. A representative of the manufacturer shall be present on site during normal working hours to assist with start-up.

D. The OWNER or an authorized representative of the OWNER will be present to witness the

acceptance testing.

- E. Acceptance testing shall include but will not be limited to the following:
 - 1. Test all system components for conformance with design requirements upon completion of installation.
 - 2. Inspect all equipment for proper alignments; secure mounting and proper connections prior to start up.
 - 3. Test run time to be sufficient to demonstrate proper operation of all system components.
 - 4. All system components shall be tested in the presence of and to the satisfaction of the ENGINEER.
 - 5. All system deficiencies shall be corrected at the CONTRACTOR'S expense. Failure to correct deficiencies will be cause for rejection of the system.
- F. Certify in writing to the ENGINEER that the equipment has been properly installed, fully functional, and ready to use.

END OF SECTION

ATTACHMENT 1

EQUIPMENT MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

Owner Navajo Tribal Utility Authority

Project _____

Project No. _____

Equipment Specification Section _____

Equipment Description _____

I _____, authorized representative of
(Print Name)

(Print Manufacturer's/Supplier's Name)

hereby CERTIFY that _____

(Print Equipment Name and Model with Serial No.)

Installed for the subject has (have) been installed in a satisfactory manner, has (have) been tested and adjusted, and is (are) ready for Final Acceptance Testing and Operation on:

Date _____

Time _____

CERTIFIED BY: _____
(Signature of Manufacturer's/Supplier's Representative)

Date _____

ATTACHMENT 2

EQUIPMENT MANUFACTURER'S CERTIFICATE OF EQUIPMENT PERFORMANCE

Owner Navajo Tribal Utility Authority

Project _____

Project No. _____

Equipment Specification Section _____

Equipment Description _____

I _____, authorized representative of
(Print Name)

(Print Manufacturer's/Supplier's Name)

hereby CERTIFY that I have inspected, reviewed and concur with the condition, operations, and performance of _____

(Print Equipment Name and Model with Serial No.)

The following deficiencies are hereby noted, as also witnessed by the Contractor and Owner, for the subject project: _____

Deficiencies Addressed and Accepted: _____

Performance Inspection Dates: _____

CERTIFIED BY: _____
(Signature of Manufacturer's/Supplier's Representative)

CERTIFIED BY: _____
(Signature of Contractor)

ATTACHMENT 3

EQUIPMENT MANUFACTURER'S CERTIFICATE OF INSTRUCTION

Owner Navajo Tribal Utility Authority

Project _____

EQUIPMENT SPECIFICATION SECTION: _____

EQUIPMENT DESCRIPTION:

I, _____ Authorized representative of
(Print Name)

(Print Manufacturer's Name)

hereby CERTIFY that _____
(Print equipment name and model with serial No.)

installed for the subject project [has] [have] been installed in a satisfactory manner, [has] [have] been satisfactorily tested, [is] [are] ready for operation, and that Owner's assigned operating personnel have been suitably instructed in the operation, lubrication, and care of the unit[s] on
Date: _____ Time: _____.

CERTIFIED BY: _____ DATE: _____
(Signature of Manufacturer's Representative)

OWNER'S ACKNOWLEDGMENT OF MANUFACTURER'S INSTRUCTION

[I] [We] the undersigned, authorized representatives of the Navajo Tribal Utility Authority Window Rock Wastewater Plant Operating Personnel have received [classroom and] hands-on instruction on the operation, lubrication, and maintenance of the subject equipment and [am] [are] prepared to assume normal operational responsibility for the equipment:

(Print Name) (Signature) DATE: _____

(Print Name) (Signature) DATE: _____

(Print Name) (Signature) DATE: _____

SUPPLEMENTAL SECTION 01 74 23

CLEANING

PART 1: GENERAL

1.0 SUMMARY

- A. Execute cleaning during progress of the Work and at completion of the Work, as required by General Conditions.

2.0 RELATED WORK

- A. General and Supplemental General Conditions of the Contract and Division 1
- B. Each Specification Section: Cleaning for specific products or work.

3.0 REFERENCES AND DEFINITIONS

- A. Where all or part of a Federal, ASTM, ANSI, AWWA, Arizona Uniform Standard Specification for Public Works Construction etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.

4.0 SUBMITTALS

- A. General: Submit listed submittals (7) in accordance with conditions of the Contract and with Specification 01 33 00.
- B. Product Data: Submit product data, including manufacturer's specifications, installation instructions, and general recommendations for installation. Also include manufacturer's certification or other data substantiating that products comply with requirements of Contract Documents. Clearly identify product/model to be used.
- C. Test Reports: Submit for acceptance, complete test reports from approved independent testing laboratories certifying that product conforms to performance characteristics and testing requirements specified herein.
- D. Shop drawings: Submit clear, concise drawing showing model number, size, arrangement and configuration of all products specified. Minimum sheet size is 8.5" X 11".

5.0 DISPOSAL REQUIREMENTS

- A. All excess material (suitable or unsuitable) and all vegetation, trash, debris, etc, from the excavation shall be disposed of off-site at a location approved by the ENGINEER.
- B. The CONTRACTOR shall make his own arrangements for disposal subject to submission of proof to the ENGINEER that the OWNER(S) of the proposed site(s) has (have) a valid fill permit issued by the appropriate governmental agency.

- C. The CONTRACTOR shall provide watertight conveyance of any liquid, semi-liquid, or saturated solids which tend to bleed or leak during transport. No liquid loss from transported materials will be permitted whether being delivered to the construction site or being hauled away for disposal. Fluid materials hauled for disposal must be specifically acceptable at the selected disposal site.
- D. The CONTRACTOR shall comply with all necessary permits, licenses and authorizations regarding the removal, transport and disposal of waste as are required by all applicable Federal, State and local laws and regulations.
- E. Trash burning will not be permitted on the construction site.

6.0 STORAGE AND HANDLING

This section not used.

PART 2: PRODUCTS

1.0 SPECIFICATIONS

This section not used.

2.0 MATERIALS

- A. Use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces.
- B. Use only those cleaning materials and methods recommended by manufacturer of the surface material to be cleaned.
- C. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

3.0 PRE-APPROVED MANUFACTURERS

This section not used.

PART 3: EXECUTION

1.0 DURING CONSTRUCTION

- A. Execute periodic cleaning to keep the Work, the site and adjacent properties free from accumulations of waste materials, rubbish and windblown debris resulting from construction operations, at no additional cost to the OWNER.
- B. Provide on-site containers for the collection of waste materials, debris and rubbish.

- C. Remove waste materials, debris and rubbish from the site periodically and dispose of at legal disposal areas away from the site.

2.0 DUST CONTROL

- A. Dust shall be minimized by the following:

1. Suppress dust on traveled paths which are not paved through wetting, use of water trucks, chemical dust suppressants, or other reasonable precautions to prevent dust entering ambient air;
2. Cover trucks when hauling soil;
3. Minimize soil track-out by washing or cleaning truck wheels before leaving construction site;
4. Stabilize the surface of soil piles;
5. Create windbreaks.

- B. Site restoration:

- a) Remove un-used material;
- b) Remove soil piles via covered trucks.

- C. The operation of dumping rock and of carrying rock away in trucks shall be so conducted as to cause a minimum of noise and dust.
- D. Vehicles carrying rock, concrete, or other material shall be routed over such streets as will cause the least annoyance to the public.
- E. All unpaved streets, roads, detours, or haul roads used in the construction area shall be given an approve dust-preventative treatment or periodically watered to prevent dust as directed by the ENGINEER.
- F. Clean interior spaces prior to the start of finish painting and continue cleaning on an as-needed basis until painting is finished.
- G. Schedule operations so that resulting from the cleaning process will not fall on wet or newly coated surfaces.

3.0 PREPARATION

- A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels and other foreign materials from sight-exposed interior and exterior surfaces.
- B. Broom clean exterior paved surfaces; rake clean other surfaces of the grounds.

- C. Prior to final completion of OWNER occupancy, CONTRACTOR shall conduct an inspection of sight-exposed interior and exterior surfaces, and all work areas, to verify that the entire Work is clean.

4.0 OPERATIONS AND MAINTENANCE MANUALS

This section not used.

5.0 WARRANTY

This section not used.

END OF SECTION

SUPPLEMENTAL SECTION 01 77 23

OPERATING AND MAINTENANCE DATA

PART 1: GENERAL

1.0 WORK INCLUDED

- A. Compile product data and related information appropriate to CONTRACTOR'S installation and for OWNER'S maintenance and operation of products furnished under the Contract.
- B. Prepare operating and maintenance data, as specified in this Section and as referenced in other pertinent sections of Specifications.
- C. Instruct OWNER'S personnel in the maintenance of products and in the operation of equipment and systems.
- D. Equipment requiring operating and maintenance submittals are listed in Section 01 33 00.
- E. O&M manual shall be submitted in a neat and orderly manner with all information clearly depicted and typed. Charts, graphs, figures, and pictures shall be original and if necessary for O&M, in color.

2.0 RELATED WORK

- A. General and Supplemental General Conditions of the Contract and Division 1
- B. Section 01 78 39: Project Record Documents
- C. Section 01 33 00: Submittal Procedures
- D. Division 25 and 26: Electrical General

3.0 REFERENCES AND DEFINITIONS

- A. Where all or part of a Federal, ASTM, ANSI, AWWA, Arizona Uniform Standard Specification for Public Works Construction etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.

4.0 SUBMITTALS

- A. General: Submit listed submittals in numeration listed herein in accordance with conditions of the Contract and with Specification 01 33 00: Submittal Procedures Section. Submittal cover letter shall include:
 - 1. Project name and number
 - 2. Description
 - 3. Contractor
 - 4. Owner

5. Subcontractor (if applicable)
6. Supplier
7. Manufacturer
8. Pertinent Specification(s) and Drawings
9. Date of Submission and the dates of all previous submissions

B. Prepare data in the form of an instructional manual for use by OWNER'S personnel.

C. Format:

1. Size: 8 ½" x 11"
2. Paper: 20 lb minimum, white, for typed pages.
3. Text:
 - a) Manufacturer's printed data.
 - b) Neatly typewritten.
4. Drawings:
 - a) Provide reinforced, punched binder tab; bind in with text.
 - b) Reduced to 8 ½" x 11" or 11" x 17" folded to 8 ½" x 11".
 - c) Where reduction is impractical, folded and placed in 8 ½" x 11" envelopes bound in text.
 - d) Suitably identified on Drawings and envelopes.
5. Provide fly leaf for each separate product or each piece of operating equipment.
 - a) Provide typed description of product and major component parts of equipment.
 - i. Brand
 - ii. Model
 - iii. Serial Number
 - b) Provide indexed tabs.
6. Cover:
 - a) Identify each volume with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS".

- b) List:
 - i. Title of Project
 - ii. Identity of separate structure as applicable.

Identity of general subject matter covered in manual.

7. Assembly:

- a) Assemble and bind material in the same order as specified in Paragraph 5.0.
- b) Material grouped in the same manner as the applicable portions of the Contract Documents.

D. Binders:

- 1. Preliminary manuals; heavy paper covers.
- 2. Final manuals: commercial-quality, substantial, permanent, 3-ring or 3 post binders with durable, cleanable plastic covers of adequate size to easily contain required information.

5.0 CONTENT OF MANUALS

A. Neatly typewritten table of contents for each volume, arranged in a systematic order.

- 1. CONTRACTOR, name of responsible principal, address and telephone number.
- 2. A list of each product required to be included, indexed to the content of the volume.
- 3. List, with each product, the name, address and telephone number of:
 - a) Subcontractor or installer.
 - b) Maintenance contractor, as appropriate.
 - c) Identify the area of responsibility of each.
 - d) Local source of supply for parts and replacement.
 - e) Manufacturer.
- 4. Identify each product by product name and other identifying symbols as set forth in Contract Documents.

B. Product Data:

- 1. Include only those sheets which are pertinent to the specific product.

2. Annotate each sheet to:
 - a) Clearly identify the specific product or part installed.
 - b) Clearly identify the data applicable to the installation.
 - c) Delete references to inapplicable information.
3. Preventive maintenance information shall be given for each major component of every piece of equipment in the format included in this Section.

C. Drawings:

1. Supplement product data with Drawings as necessary to clearly illustrate:
 - a) Relations of component parts of equipment and systems.
 - b) Control and flow diagrams.
2. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation.
3. Do not use Project Record Documents as maintenance drawings.

D. Written text as required to supplement product data for the particular installation:

1. Organize in a consistent format under separate headings for different procedures.
2. Provide a logical sequence of instructions for each procedure.

E. Copy of each warranty, bond and service contract issued:

1. Provide information sheet for OWNER'S personnel; give:
 - a) Proper procedures in the event of failure.
 - b) Instances which might affect the validity of warranties or bonds.

F. Provide an installation, operation and maintenance manual for each item of equipment or system listed in the schedule of manuals, in the quantity listed in the submittal schedule.

G. Content for each unit of equipment and system, as appropriate.

1. Description of unit and component parts:
 - a) Function, normal operating characteristics and limiting conditions.
 - b) Performance curves, engineering data and tests.

- c) Complete nomenclature and commercial number of all replaceable parts.
2. Manufacturer's complete installation instructions and recommendations.
3. Operating procedure:
 - a) Startup, break-in, routine and normal operating instructions.
 - b) Regulation, control, stopping, shutdown and emergency instructions.
 - c) Summer and winter operating instructions, as applicable.
 - d) Special operating instructions.
4. Maintenance procedures:
 - a) Routine operations.
 - b) Guide to "trouble-shooting".
 - c) Disassembly, repair and reassembly.
 - d) Alignment, adjusting and checking.
 - e) Provide preventive maintenance information for each major component of every piece of equipment as required on the "Preventive Maintenance Information & Equipment Data Sheet" attached at the end of this Section.
5. Servicing and lubrication schedule:
 - a) List of lubricants required.
 - b) Provide lubrication information for each major component of every piece of equipment as required on the "Preventive Maintenance Information & Equipment Data Sheet" attached at the end of this Section.
6. Manufacturer's printed operating and maintenance instructions.
7. Description of sequence of operation.
8. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
 - a) Predicted life of parts subject to wear.
 - b) List of original manufacturer's spare parts, manufacturer's current prices and recommended quantities to be maintained in storage for a minimum of one year.
9. As-installed control diagrams.

10. Other data as required under pertinent sections of Specifications.
- H. Content, for each electric and electronic item or system, as appropriate:
1. Description of system and component parts:
 - a) Function, normal operating characteristics and limiting conditions.
 - b) Performance curves, engineering data and tests.
 - c) Complete nomenclature and commercial number of replaceable parts.
 2. Circuit directories of panelboards:
 - a) Electrical service.
 - b) Controls.
 - c) Communications.
 3. As-installed color coded wiring diagrams.
 4. Operating procedures:
 - a) Routine and normal operating instructions.
 - b) Sequences required.
 - c) Special operating instructions.
 5. Maintenance procedures:
 - a) Routine operations.
 - b) Guide to "trouble-shooting"
 - c) Adjustment and checking
 - d) Calibration procedures
 6. Manufacturer's printed operating and maintenance instructions.
 7. List of original manufacturer's spare parts, manufacturer's current prices and recommended quantities to be maintained in storage.
 8. Other data as required under pertinent sections of Specifications.
- I. Prepare and include additional data when the need for such data becomes apparent during instruction of OWNER'S personnel, or as necessary to provide complete operation and maintenance instructions.

- J. Photo; submit 1 (one) electrical and 1 (one) hard copy set for each piece of equipment:
 - 1. Picture of Final Installed Equipment
 - 2. Nameplate data as listed in Attachment 1
- K. Additional requirements for operating and maintenance data: the respective sections of Specifications.

6.0 SUBMITTAL SCHEDULE

A. Manuals for Equipment and Systems:

- a) Submit two preliminary copies prior to the date of shipment of the equipment or system. Manual shall be marked preliminary. ENGINEER shall review.
 - b) If acceptable:
 - i. One copy shall be returned to CONTRACTOR.
 - ii. One copy shall be retained in ENGINEER'S files.
 - c) If unacceptable:
 - i. One copy shall be returned to CONTRACTOR and ENGINEER'S comments for revision.
 - ii. One copy shall be retained in ENGINEER'S files.
 - iii. Resubmit two revised preliminary copies for ENGINEER'S review.
 - iv. Once the ENGINEER has determined that a manual is not acceptable, the remainder of the manual shall not be reviewed in detail.
 - d) No partial payments shall be made for equipment and systems either on hand or installed until preliminary manuals are submitted and acceptable to the ENGINEER.
2. Submit five final copies no less than 30 days prior to putting the equipment or system in service.
- a) ENGINEER shall compare with accepted preliminary manual.
 - b) If identical or otherwise acceptable:
 - i. One copy shall be returned to CONTRACTOR for project record documents.
 - ii. One copy shall be retained by ENGINEER.
 - iii. Three copies shall be held for later transmittal to OWNER.
 - c) If not acceptable:
 - i. All five copies shall be returned to CONTRACTOR for revision or retained

- by ENGINEER.
 - ii. The necessary revision data shall be requested from CONTRACTOR, at ENGINEER'S option.
 - d) No portion of the Work is substantially complete until final equipment and system manuals relating to that portion of the Work are accepted by ENGINEER.
 - e) Submit five copies of any revisions found desirable during instruction of OWNER'S personnel, with instructions for revising copies of manual.
3. If CONTRACTOR requires additional copies of the operation and maintenance manuals for the CONTRACTOR'S, subcontractor's or suppliers' use, such may be submitted and shall be returned upon review by the ENGINEER.

7.0 INSTRUCTION OF OWNER'S PERSONNEL

- A. Prior to final inspection or acceptance, fully instruct OWNER'S designated operating and maintenance personnel in the operation, adjustment and maintenance of all scheduled products, equipment and systems.
- B. Operating and maintenance manual shall constitute the basis of instruction:
 - 1. Contents of manual reviewed with OWNER'S personnel in full detail to explain all aspects of operations and maintenance.
 - 2. Training of personnel:
 - a) In the field, review operation and maintenance, in full detail with OWNER'S personnel, each scheduled system or equipment.
 - b) Training assistance shall not be considered complete until after equipment is fully operational and checked out and functioning satisfactorily.
 - c) If training is given before equipment is completely operational, representative shall have to repeat training after equipment is fully operational.
- C. Additional requirements for specialized instruction of OWNER'S personnel are given in the detailed equipment specifications.
- D. Scheduled two weeks in advance in coordination with both the ENGINEER and OWNER'S operating personnel.
- E. Instruction to be performed by a qualified, experienced, regular employee of the equipment or system manufacturer, or a full time field service representative (not sales personnel) approved by the equipment or system manufacturer.
- F. If the ENGINEER judges the instruction to be incomplete, inadequate or inaccurate, additional instruction shall be scheduled and provided at no additional cost to the OWNER.

8.0 VIDEOTAPING OF MANUFACTURER'S INSTRUCTION

- A. As scheduled, the ENGINEER or OWNER may videotape the equipment manufacturer's instruction to the OWNER'S personnel.
- B. For instruction to be videotaped, persons providing the instruction shall:
 - 1. Provide to ENGINEER the following:
 - a) When instruction is to be scheduled.
 - b) Detailed outline of topics, materials, procedures, information, etc. to be covered during instruction.
 - 2. Provide instruction in easily-videotaped format and presentation

9.0 SPARE PARTS AND MAINTENANCE MATERIALS

- A. Provide spare parts and maintenance materials as specified in this Section and in equipment specifications sections.
- B. MAINTENANCE MATERIALS
 - 1. Provide:
 - a) Lubricant for all equipment and facilities sufficient for three months' normal usage.
 - b) Any non-standard tools required adjusting or service equipment supplied.
 - 2. Label all materials by equipment name and usage.
- C. SPARE PARTS
 - 1. Label and identify by equipment name, part name and part number.
 - 2. Packaged for storage.

10.0 QUALITY ASSURANCE

- A. Preparation of data shall be done by personnel:
 - 1. Trained and experienced in maintenance and operation of the described products.
 - 2. Completely familiar with requirements of this Section.
 - 3. Skilled as technical writers to the extent required to communicate essential data.
 - 4. Skilled as draftsmen competent to prepare required Drawings.

PART 2: PRODUCTS

This section not used

PART 3: EXECUTION

This section not used.

END OF SECTION

ATTACHMENT: PREVENTATIVE MAINTENANCE INFORMATION AND EQUIPMENT DATA SHEET

ATTACHMENT

PREVENTATIVE MAINTENANCE INFORMATION
AND
EQUIPMENT DATA SHEET

1. Equipment Name:

2. Equipment Model Number:

3. Equipment Manufacturer:

Contact:

Address:

Phone:

4. Equipment Supplier:

Contact:

Address:

Phone:

5. Nameplate Data:

Drive Unit _____ HP _____ RPM _____ Volts _____ Phase _____
Motor Class (drip-proof, TREFC, etc.) _____
Manufacturer Model No. _____ Serial No. _____
Other (Capacity, Speed, etc.) _____
Driven Unit: Flow with Units _____
Discharge Pressure with Units _____
Equipment Type _____
Model No. _____ Serial No. _____
Other _____

6. Method of Power Transmission (direct coupled, V-belt, etc.)

ATTACHMENT

7. Maintenance Requirements

Maintenance Operation: List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable.

Frequency : List required frequency if each maintenance operation.

Lubricant (if applicable): Refer by symbol to recommended lubricant from list in Item 8.

Comments: Give other applicable comments concerning maintenance operation.

<u>Maintenance Operation</u>	<u>Frequency</u>	<u>Lubricant</u>	<u>Comments*</u>
------------------------------	------------------	------------------	------------------

A.

B.

C.

*Comments – including any special tools required.

Use additional sheets if necessary.

8. Lubricant List (provide Mobile number in addition to any other recommended manufacturers):

<u>Reference Symbol</u>	<u>Mobile</u>	<u>Standard Oil</u>	<u>Gulf Arc</u>	<u>or Equal</u>
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List symbols used in Item 7 above.

List equivalent lubricants, as distributed by each manufacturer for specific use recommended.

This data sheet prepared by:

Firm:

Date:

SUPPLEMENTAL SECTION 01 78 39

PROJECT RECORD DOCUMENTS

PART 1: GENERAL

1.0 SUMMARY

- A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:
1. Record Drawings.
 2. Record Specifications.
 3. Record Product Data.

2.0 RELATED WORK

- A. General and Supplemental General Conditions of the Contract and Division 1

3.0 REFERENCES AND DEFINITIONS

- A. Where all or part of a Federal, ASTM, ANSI, AWWA, and Arizona Uniform Standard Specification for Public Works Construction etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.

4.0 SUBMITTALS

- A. General: Submit listed submittals (7) in accordance with conditions of the Contract and with Specification 01 33 00: Submittal Procedures Section. Submittal cover letter shall include:
1. Project name and number
 2. Description
 3. Contractor
 4. Owner
 5. Subcontractor (if applicable)
 6. Supplier
 7. Manufacturer
 8. Pertinent Specification(s) and Drawings
 9. Date of Submission and the dates of all previous submissions
- B. Product Data: Submit product data, including manufacturer's specifications, installation instructions, and general recommendations for installation. Also include manufacturer's certification or other data substantiating that products comply with requirements of Contract Documents. Clearly identify product/model to be used.
- C. Test Reports: Submit for acceptance, complete test reports from approved independent testing laboratories certifying that product conforms to performance characteristics and testing requirements specified herein.

- D. Shop drawings: Submit clear, concise drawing showing model number, size, arrangement and configuration of all products specified. Minimum sheet size is 8.5" X 11".

PART 2: PRODUCTS

This section not used.

PART 3: EXECUTION

1.0 EXAMINATION

- A. Examine all products for compliance with this section.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

2.0 RECORD DRAWINGS

- A. Record Prints: Maintain one set of red-lined prints of the Contract Drawings and Shop Drawings. These prints shall be updated no less frequently than once per week. These prints will be reviewed for verification of updates by the construction observer on a regular basis, depending on the length of the contract. Immediately before inspection for Certificate of Substantial Completion, review marked-up Record Prints with ENGINEER.
- B. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Mark whichever drawing is most capable of showing "field" conditions fully. Require individual or entity who obtained record data, whether individual or entity is Installer, sub-CONTRACTOR, or similar entity, to prepare the marked-up Record Prints.
 - 1. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - 2. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
 - 3. The record drawings shall clearly and neatly show all changes.
 - a) Additions marked in red.
 - b) Deletions marked in green.
 - c) Comments marked in blue.
 - d) Installed systems in yellow.
- C. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-references on the Contract Drawings.
- D. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.

- E. Note Construction Change Directive numbers (field orders or Request for Information changes), alternate numbers, Change Order numbers, and similar identification, where applicable.
- F. Verification of current record prints status will be included in the monthly payment approval process that will be noted by the construction's observer's field reports.

3.0 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 - 3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 - 4. Note related Change Orders, field order notes, Request for Information (RFI) notes, Record Product Data, and Record Drawings where applicable.

4.0 RECORD PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 - 3. Note related Change Orders, Record Specifications, and Record Drawings where applicable.

5.0 MISCELLANEOUS RECORD SUBMITTALS

- A. Operation and Maintenance Manuals: Organize the operational and maintenance manual information into suitable sets of manageable size and bind into individual binders properly identified and indexed. Include pocket folders for folded sheet information.
- B. Assemble Certifications, Lab Test Reports, and Field Test Reports required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

6.0 RECORDING AND MAINTENANCE

- A. Per Section 01 77 23 Operating and Maintenance Data, the Manufacturer shall provide 3 copies of the operations and maintenance manuals which shall include the assembly and installation instructions. Operation and maintenance instructions which rely on vendor cut-sheets and literature which include general configurations, or require operating personnel to selectively read portions of the manual shall not be acceptable. Operation and maintenance instructions must be specific to equipment supplied in accordance with these specifications.
- B. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur.
- C. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. It is not advisable to use Project Record Documents for construction purposes. Provide access to Project Record Documents for ENGINEER'S reference on the project site.

END OF SECTION

SUPPLEMENTAL SECTION 02 41 00

DEMOLITION

PART 1: GENERAL

1.0 SUMMARY

- A. Demolition of existing facilities as indicated on Drawings and/or required for completion of Work under contract.
- B. Protection of existing structures, utilities, and items not scheduled for removal.

2.0 RELATED WORK

- A. General and Supplemental General Conditions of the Contract and Division 1.

3.0 REFERENCES AND DEFINITIONS

- A. Where all or part of a Federal, ASTM, ANSI, AWWA, and Arizona Uniform Standard Specification for Public Works Construction etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.

4.0 SUBMITTALS

- A. Indicate demolition and removal sequence and location of salvageable items; location of temporary work. Describe demolition and removal procedures and schedule.
- B. Record actual locations of capped utilities and equipment abandoned in place.

5.0 QUALITY ASSURANCE

This section not used.

6.0 STORAGE AND HANDLING

- A. The CONTRACTOR shall be responsible for the safe storage of the equipment until it is incorporated in the completed project.

PART 2: PRODUCTS

This section not used.

PART 3: EXECUTION

1.0 GENERAL

- A. Carry out demolition work to cause as little inconvenience to the ongoing use of the existing wastewater treatment plant as possible.
- B. Remove all concrete debris, mechanical equipment, interior piping and electrical equipment, as indicated in Drawings, and return to OWNER at OWNER'S yard or dispose of if so directed.
- C. Plug all exposed pipe lines remaining in place with grout.
- D. Fill all structures and excavations with compacted, clean, pit-run sand and/or gravel.
- E. Leave site in a lean, orderly, neat-appearing manner.
- F. Comply with all applicable State and Federal Regulations.

2.0 DEMOLITION

- A. Demolish in an orderly and careful manner as required to accommodate the new Work.
- B. Repair all demolition performed in excess of that required, at no additional cost to the OWNER.
- C. Onsite disposal or burning of materials shall not be permitted.

3.0 DEMOLITION OF EXISTING SEWER INFRASTRUCTURE

- A. For decommissioning of existing sewer infrastructure components, arrange for a licensed septic hauler to empty the tanks or piping. Properly dispose of the septage.
- B. Plug any existing lines that will be abandoned.
- C. The unit shall be completely filled with earth, sand, gravel concrete, or other approved material. Fill material shall consist of material less than three inches in diameter and free of organic debris.
- D. Remove the top cover or arch over the unit before filling.
- E. The filling shall not extend above the top of the vertical portions of the sidewalls or above the level of any outlet pipe until inspection by the OWNER'S representative.
- F. After such inspection, the unit shall be filled to the level of the top of the ground.

4.0 REMOVAL OF DEBRIS

- A. Remove demolished materials, debris, and rubbish from the site and dispose of in accordance with State and Federal requirements.
- B. Remove tools and equipment from the site upon completion of the Work. Leave site in a condition acceptable to the OWNER.

5.0 SCHEDULE OF DEMOLITION

A. As indicated on the Drawings.

6.0 ADDITIONAL REQUIREMENTS

A. Disposal:

1. Location and method for the disposal of refuse and abandoned equipment shall be at a permitted solid waste disposal facility.
2. Disposal of such matter is the CONTRACTOR'S full responsibility.

END OF SECTION

SUPPLEMENTAL SECTION 03 12 00

CONCRETE FORMWORK

PART 1: GENERAL

1.0 RELATED WORK

A. Applicable provisions of Division 1 shall govern all work of this Section.

2.0 WORK INCLUDED

A. Include materials, labor, services and incidentals necessary for completion of this Section of Work.

B. Include formwork for cast-in-place concrete as required by Concrete CONTRACTOR.

C. Include formwork for concrete bases for equipment of mechanical and electrical divisions. CONTRACTORS for those divisions of Work shall be responsible for size, location and required inserts.

D. Notify trades in ample time for each to install own work required in conjunction with formwork.

E. Inserts, sleeves and other miscellaneous embedded items required by mechanical, electrical or plumbing trades shall be supplied and installed by those respective trades.

F. Provide and install inserts, sleeves and other miscellaneous embedded items other than those required by mechanical, electrical or plumbing trades.

G. Supply, install and maintain shoring and re-shoring related to concrete formwork.

3.0 REFERENCES AND DEFINITIONS

A. Where all or part of a Federal, ASTM, ANSI, AWWA, and Arizona Uniform Standard Specification for Public Works Construction etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.

B. American Concrete Institute (ACI)

1. ACI 301 Specifications for Structural Concrete for Buildings
2. ACI 318 Building Code Requirements for Structural Concrete
3. ACI 347 Guide to Formwork for Concrete

C. National Forest Products Association (NFPA)

1. NDS National Design Specification for Wood Construction including Design Values for Wood Construction

D. The Engineered Wood Association (APA)

1. Plywood Design Specification

4.0 SUBMITTALS

- A. General: Submit listed submittals in accordance with conditions of the Contract and with Specification 01 33 00.
- B. Product Data: Submit product data, including manufacturer's specifications, installation instructions, and general recommendations for installation. Also include manufacturer's certification or other data substantiating that products comply with requirements of Contract Documents. Clearly identify product/model to be used.
- C. Test Reports: Submit for acceptance, complete test reports from approved independent testing laboratories certifying that product conforms to performance characteristics and testing requirements specified herein.
- D. Shop drawings: Submit clear, concise drawing showing model number, size, arrangement and configuration of all products specified. Minimum sheet size is 8.5" X 11".

5.0 QUALITY ASSURANCE

A. Industry Standards, Specifications and Codes:

1. Comply with provisions of the following codes and standards except as modified herein.
2. Referenced codes and standards including revisions and commentaries shall be the most currently adopted as of the date of these Contract Documents.
3. Inspect and check completed formwork, shoring and bracing to ensure work is in accordance with formwork design and supports, fastenings, wedges, ties and parts are secured.
4. Clean and repair surfaces of forms to be reused in Work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. Apply new form coating compound material to concrete contact form surfaces as specified for new formwork.
5. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joints to avoid offsets. Do not use "patched" forms for exposed concrete surfaces. Do not use metal cover plates for repairing defects in forms for exposed concrete work.

6. Inform ENGINEER when formwork is complete and has been cleaned to allow for inspection. Obtain review prior to placing concrete.
7. For exposed to view concrete surfaces do not reuse plywood formwork.
8. Allow ENGINEER to inspect each section of plywood type formwork prior to reuse.

6.0 STORAGE AND HANDLING

- A. The CONTRACTOR shall be responsible for the safe storage of the equipment until it is incorporated in the completed project.

PART 2: PRODUCTS

1.0 SPECIFICATIONS

- A. Design forms, shores and bracing. Include factors pertaining to safety of formwork structure such as live load, dead load, weight of equipment on formwork, concrete mix, height of concrete drop, vibration reactions and similar factors.
- B. Design formwork to be readily removable without impact, shock or damage to cast-in-place concrete surfaces and adjacent materials.

2.0 MATERIALS

A. FORM MATERIALS

1. General: Plywood, metal-framed plywood-faced or other acceptable panel type materials to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practical sizes to minimize number of joints. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection.
2. Formed Surfaces Exposed To View: New plywood complying with U.S. Standard PS-1 Plyform Class I, B-B Concrete Form Plywood, B-Matte MDO Plywood by Simpson, 5/8 inch or 3/4 inch thick without defects, mill oiled and edge sealed or wood forms lined with 3/16 inch tempered pressed wood or 1/4 inch thick plywood B-B conforming to EXT-DFPA as large a size as possible to minimize joints.
3. Formed Surfaces Concealed From View: Clean straight lumber dressed on face and edges, nominal 1 inch thickness or plywood 5/8 inch or 3/4 inch thick conforming to EXT-DFPA or metal forms smooth and as large a size as possible.
4. Reveals and Chamfers: Wood or purpose-made plastic or high density plastic foam to achieve sharp, true lines.

B. FORMWORK ACCESSORIES

1. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sizes as required of sufficient strength and character to maintain formwork in place while placing concrete.
2. Form Ties:
 - a) For Unexposed Concrete: Adjustable length removable or snap-off type which will leave holes no larger than 1 inch in diameter in face of concrete and when forms are removed no metal will be within 1 inch of finished concrete surface.
 - b) For Exposed Concrete: Ties shall be snap-off type (break point 1 inch or more from surface) with plastic cones added to form a 1-1/4 inch diameter, 1-1/2 inch deep recess around tie, which shall be grouted flush to match adjacent concrete surface.
 - c) For Concrete in Liquid-Containing Structures: Taper ties with watertight plug, placed with larger diameter toward the interior.
 - d) No wire ties or site fabricated ties permitted.

C. CONCRETE ACCESSORIES

- a) Dovetail Anchor Slots: #305 Hohman and Barnard, Inc. or equivalent 20 gage sheet metal in Eraydo Zinc with felt strip protector.
- b) Wedge-Type Inserts: Hot rolled steel with wedge shaped holding faces designed to receive a 3/4 inch hot dipped galvanized askew head bolt. Gateway Type SL-R hot dipped galvanized or equivalent.
- c) Waterstops: PVC or SBR type, purpose made, split serrated type, center bulb, self sealing non-swelling joint sealant.

D. FORM COATINGS

1. Form coatings for exposed concrete shall consist of an approved non-staining form oil, lacquer or plastic. Plywood approved for reuse shall be recoated as directed by ENGINEER. When oil is used, excess shall be wiped off with rags. When lacquer is used, a light coating of form oil over lacquer will be permitted provided excess is wiped off. When factory-applied plastic coatings are used, follow manufacturer's instructions. Contact surface of forms shall be free of foreign matter, including dust. Form oil shall be applied to forms before reinforcing is erected. Form oil shall be of type which will not affect bonding of specified exterior finish.

E. CONSTRUCTION JOINT MATERIALS

1. Solid Wood Lumber: Spruce-Pine-Fir (SPF) #2 or equivalent.

3.0 PRE-APPROVED MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work, include, but are not limited to, the following:
 - 1. As noted throughout this section.
- B. Substitutions /or Equal: If alternative manufacturers other than the pre-approved manufacturer are proposed for any specified equipment in this section, the CONTRACTOR/bidder must supply a submittal, refer to STS 01 33 00.
- C. Although the brands listed herein are the preferred brands, it is not the intent of the OWNER for these specifications to be proprietary; equals will be evaluated in accordance with comparable quality, construction, strength, durability, and suitability for the purpose intended and are listed for the purpose of describing the standard of quality performance and characteristics.
- D. Manufacturers listed in this specification do not constitute approval. All equipment must have the capabilities and functions as specified herein.

PART 3: EXECUTION

1.0 CONTRACTOR'S RESPONSIBILITY

- A. The CONTRACTOR is responsible for furnishing and installing the PRODUCT including all site preparation, and other items necessary for the proper installation and operation of the PRODUCT.

2.0 EXAMINATION

- A. Examine all products for compliance with this section.
- B. Proceed with installation only after unsatisfactory conditions have been corrected

3.0 PREPARATION

- A. Verify lines, levels and centers before proceeding with formwork. Ensure dimensions agree with Drawings.

B. COORDINATION

- 1. Coordinate work of other sections and cooperate with trades involved in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors and other inserts. Do not perform work unless specifically indicated on Drawings or reviewed prior to installation.

4.0 INSTALLATION

A. FORMWORK ERECTION

- 1. Erect, support, brace and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by concrete structure. Construct formwork so

concrete members and structures are of correct size, shape, alignment, elevation and position. Form both faces of foundations. Earth forming of footings and vertical surfaces of concrete work is not permitted.

2. Construct forms to sizes, shapes, lines and dimensions shown on Drawings and to obtain accurate alignment, location and grades. Level and plumb work. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of cement paste.
3. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crust plates or wrecking plates where stripping may damage concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses and like to prevent swelling and for easy removal.
4. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.
5. At all exposed corners of concrete walls, beams, columns, slab edges and miscellaneous items not specified or indicated, provide 3/4 inch, 45 degree chamfer.
6. Install ties so portion remaining within concrete after removal is at least 1 inch inside concrete. Remove so surrounding concrete is not disfigured and cleanout hole remains to be patched.
7. Coat contact surfaces of forms with form-coating compound before reinforcement is placed.
8. Thin form coating compounds only with thinning agent of type and in amount and under conditions of form coating compound manufacturer's directions. Do not allow excess form coating material to accumulate in forms or to come into contact with concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

B. INSERTS, EMBEDDED PARTS AND OPENINGS

1. Plumbing, Heating and Electrical Items:
 - a) Pre-manufactured items including inserts, sleeves and other embedded items required by mechanical, electrical and plumbing trades shall be supplied, accurately located, and installed by respective trades.
 - b) Site fabricated box outs for chases, sleeves and other miscellaneous openings for mechanical, electrical and plumbing trades shall be supplied and installed by

Formwork CONTRACTOR.

- c) Location of mechanical, electrical and plumbing inserts, embedded parts, openings and recesses shall be coordinated with respective trades by General CONTRACTOR.

2. Other Items:

- a) Other inserts, embedded parts, box outs for openings, chases, reveals and recesses except those specifically mentioned above by mechanical, electrical or plumbing trades, shall be installed by Formwork CONTRACTOR. Special inserts, embedded parts or other special requirements needed by specific trades shall be supplied by that respective trade to Formwork CONTRACTOR for installation. General CONTRACTOR shall have overall responsibility for coordinating location of inserts, embedded parts, openings and recesses.
- b) Install concrete accessories in accordance with manufacturer's recommendations; straight, level and plumb. Ensure items are not disturbed during concrete placement.
- c) Set and build into Work, anchorage devices and other embedded items required for other work attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions and directions provided by suppliers of items to be attached. Build-in dovetail anchor slots vertically.
- d) Build-in wedge inserts indicated.

C. JOINTS AND EDGE FORMS

- 1. Locate construction joints as shown on Drawings or as approved by ENGINEER. Form with keyway. Place perpendicular to main reinforcement. Continue reinforcement through joint, except slabs-on-grade, and locate joint so as not to affect structural integrity or appearance of structure. Includes joint between wall and footing.
- 2. Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units of sufficient strength to support types of screeds required. Align concrete surface to elevation of screed strips by use of strike-off templates or accepted compacting type screeds.

D. METAL FLOOR DECK SHORING

- 1. Shore metal floor deck at mid-span or more frequently as required to maintain a maximum deflection of 1/4 inch after placing concrete. Shore from bottom flange of supporting beams. Retain shores in place until concrete has attained 70 percent of design strength.

E. FORMWORK REMOVAL

1. Notify ENGINEER and OWNER'S field representative prior to removing formwork, centering, shoring and re-shoring.
2. Remove forms in a manner to insure safety of structure at all times. Where entire structure is supported on shores; beam and girder sides, columns and similar vertical forms may be removed after 48 hours, providing concrete is sufficiently hard not to be injured thereby. In no case shall supporting forms or shoring be removed until members have acquired sufficient strength to support their weight and load safely. Coordinate removal with work of other trades.
3. Remove forms according to ACI-347. However, the following schedule shall govern the minimum waiting period after placing concrete before bottom forms and shores of similar false work supporting flexural members such as girders, beams, joists, slabs, etc. may be disturbed or stripped:

<u>Structural Members</u>	<u>Waiting Period</u>
Columns, walls and beam sides	2 days
Spans less than 12 foot - slabs and beam bottoms	7 days
Spans between 12 foot and 30 foot - slabs and beam bottoms	14 days
Spans greater than 30 foot - slabs and beam bottoms	28 days

4. Post-tensioned members may be stripped after tensioning. No re-shoring is required unless other construction loads will be imposed on P/T members.
5. The above schedule applies to daily curing temperatures above 50 degrees. For lower daily curing temperatures, increase waiting period. In addition to above requirements, do not remove forms until concrete has attained 80 percent of minimum design strength.
6. Re-shore removed area before removing additional adjacent formwork.
7. Retain re-shores in place for a minimum of 14 days and concrete has attained 100 percent of minimum design strength. Retain re-shores in place until concrete construction above has attained sufficient strength to not require shoring below.

5.0 WARRANTY

The PRODUCT and work shall be warranted against defects in material and workmanship for a period of one year. The warranty period shall begin after final inspection and acceptance by the project ENGINEER.

END OF SECTION

SUPPLEMENTAL SECTION 03 21 13

REINFORCING STEEL

PART 1: GENERAL

1.0 RELATED WORK

A. Applicable provisions of Division 01 shall govern all work of this Section.

2.0 SUMMARY

- A. Include materials, labor, services and incidentals necessary for completion of this Section of Work.
- B. Work includes fabrication and placement of reinforcement for cast-in-place concrete including bars, welded wire fabric, ties, dowels, stirrups, supports and accessories required.

3.0 REFERENCES AND DEFINITIONS

- A. American Concrete Institute (ACI):
1. ACI 301 Specifications for Structural Concrete for Buildings
 2. ACI 318 Building Code Requirements for Structural Concrete
 3. ACI 315 Details and Detailing of Concrete Reinforcement
 4. ACI 350 Code Requirements for Environmental Engineering Concrete Structures
- B. Concrete Reinforcing Steel Institute (CRSI):
1. Manual of Standard Practice
 2. Recommended Practice for Placing Reinforcing Bars
- C. American Society for Testing and Materials (ASTM):
1. Specific ASTM numbers are noted in later text.
- D. Where all or part of a Federal, ASTM, ANSI, AWWA, and Arizona Uniform Standard Specification for Public Works Construction etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.

4.0 SUBMITTALS

- A. General: Submit listed submittals in accordance with conditions of the Contract and with Specification 01 33 00.

- A. Product Data: Submit product data, including manufacturer's specifications, installation instructions, and general recommendations for installation. Also include manufacturer's certification or other data substantiating that products comply with requirements of Contract Documents. Clearly identify product/model to be used.
- B. Test Reports: Submit for acceptance, complete test reports from approved independent testing laboratories certifying that product conforms to performance characteristics and testing requirements specified herein.
- C. Shop drawings: Submit clear, concise drawing showing model number, size, arrangement and configuration of all products specified. Minimum sheet size is 8.5" X 11".

5.0 QUALITY ASSURANCE

A. Industry Standards, Specifications and Codes:

1. General:

- a) Comply with provisions of the following codes and standards except as modified herein.
- b) Referenced codes and standards including revisions and commentaries shall be the most currently adopted as of the date of these contract documents.

B. Acceptable Manufacturers:

- 1. Shall be regularly engaged in the manufacture of steel bar, welded wire fabric reinforcing and mechanical splicing devices.

C. Installer Qualifications:

- 1. Shall have 3 years experience in installation of steel bar and welded wire fabric reinforcing.

D. Source Quality Control:

- 1. Mill test certificates identifying chemical and physical analysis of each load of reinforcing steel delivered if requested.

E. FIELD QUALITY CONTROL

- 1. Notify ENGINEER when reinforcing is in place so he or she may review reinforcing placement. ENGINEER shall have a minimum of 24 hour notice prior to placement of concrete.
- 2. Tend to reinforcing at all times during concrete placement and make necessary adjustments to reinforcing which has been dislodged by concrete placement or workmen.

3. Bar Placement Tolerances:

- a) 1/4 inch (plus/minus) between bars
- b) 1/4 inch (plus/minus) vertically for members 8 inches deep or less
- c) 1/2 inch (plus/minus) vertically for members over 8 inches deep and less than 2 foot deep
- d) 1 inch (plus/minus) vertically for members 2 foot or deeper

6.0 STORAGE AND HANDLING

- A. The CONTRACTOR shall be responsible for the safe storage of the equipment until it is incorporated in the completed project.

PART 2: PRODUCTS

1.0 SPECIFICATIONS

A. MECHANICAL SPLICES

1. Mechanical splicing devices are to be used where specifically noted on Drawings or at CONTRACTOR'S option for any splice. Mechanical splicing devices shall develop 125 percent of designated yield strength of reinforcing being spliced.

2. Acceptable products and manufacturers are as follows:

a) COMPRESSION SPLICES:

- i. Cadweld (compression only); Erico Products, Inc.
- ii. Lenton; Erico Products, Inc.
- iii. Speed Sleeve; Erico Products, Inc.
- iv. G-Lock; Gateway
- v. Grip-Twist; Barsplice Products, Inc.

b) TENSION SPLICES:

- i. Cadweld (tension only); Erico Products, Inc.
- ii. Lenton; Erico Products, Inc.
- iii. Grip-Twist; Barsplice, Inc.
- iv. Bar-Grip System, Barsplice Products, Inc.

3. Comply with manufacturer's instructions for bar preparation and installation of splicing devices.

B. ACCESSORIES

1. Supports For Reinforcement:

- a) Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcement in place.
- b) Use wire bar type supports complying with CRSI recommendations unless otherwise indicated. Do not use wood, brick and other unacceptable materials, e.g., mortar blocks, coarse aggregates.
- c) For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic protected. For sandblasted or bush-hammered concrete provide stainless steel protected or special stainless bar supports.
- d) Where indicated on Drawings, slab on grade reinforcement shall be supported on individual high chairs with sand plates for soil bearing (HCP).
- e) Over waterproof membrane, use chairs with plates to prevent penetration of membrane.

C. FABRICATION

- 1. Shops fabricate reinforcing bars to conform to required shapes and dimensions. In case of fabricating errors, do not re-bend or straighten reinforcement in a manner that will injure or weaken materials.
- 2. Reinforcement shall be bent cold unless otherwise permitted by ENGINEER.
- 3. Unacceptable Materials:
 - a) Reinforcement with any of the following defects will not be permitted in Work:
 - i. Bar lengths, depths and bends exceeding specified fabrication tolerances.
 - ii. Bends or kinks not indicated on Drawings or final Shop Drawings.
 - iii. Bars with reduced cross-section due to excessive rusting or other cause.

D. PRODUCT DELIVERY, STORAGE AND HANDLING

- 1. General:
 - a) Deliver reinforcement to project site in bundles marked with metal tags indicating bar size, lengths and other information corresponding to markings shown on placement drawings.
 - b) Handle and store materials to prevent dirt or excessive rust.

2.0 MATERIALS

A. REINFORCING STEEL

1. Reinforcing Bars:

- a) Conform to ASTM A-615 "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement".
- b) Reinforcing bars shall be deformed, except that plain bars may be used for spirals.
- c) Main reinforcing bars and other bars not listed above shall be Grade 60, unless noted otherwise on Contract Documents.

2. Welded Wire Fabric:

- a) Conform to ASTM A-185 "Standard Specification for Welded Steel Wire Fabric, Plain for Concrete Reinforcement".
- b) Welded wire fabric shall be electrically welded and 65,000 psi yield strength.

3.0 PRE-APPROVED MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work, include, but are not limited to, the following:

1. As noted throughout this section.

B. Substitutions /or Equal: If alternative manufacturers other than the pre-approved manufacturer are proposed for any specified equipment in this section, the CONTRACTOR/bidder must supply a submittal, refer to STS 01 33 00.

C. Although the brands listed herein are the preferred brands, it is not the intent of the OWNER for these specifications to be proprietary; equals will be evaluated in accordance with comparable quality, construction, strength, durability, and suitability for the purpose intended and are listed for the purpose of describing the standard of quality performance and characteristics.

D. Manufacturers listed in this specification do not constitute approval. All equipment must have the capabilities and functions as specified herein.

PART 3: EXECUTION

1.0 CONTRACTOR'S RESPONSIBILITY

A. The CONTRACTOR is responsible for furnishing and installing the PRODUCT including all site preparation, and other items necessary for the proper installation and operation of the PRODUCT.

2.0 EXAMINATION

- A. Examine all products for compliance with this section.
- B. Proceed with installation only after unsatisfactory conditions have been corrected

3.0 PREPARATION

- A. Examine formwork and other conditions under which concrete reinforcement is to be placed and notify Formwork CONTRACTOR of unsatisfactory conditions. Do not proceed with work until unsatisfactory conditions have been corrected in a manner to your satisfaction.

4.0 INSTALLATION

A. PLACEMENT

1. Comply with specified codes and standards and CRSI "Recommended Practice for Placing Reinforcing Bars" for details and methods of reinforcement placement and supports and as specified.
2. Clean reinforcement to remove loose rust and mill scale, earth, ice and other materials which reduce or impair bond with concrete.
3. Position, support and secure reinforcement against displacement by formwork, construction or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers as required.
4. Place reinforcement to obtain coverages for concrete protection as indicated on Contract Documents. Arrange, space and securely tie bars and bar supports together with 16 gage wire to hold reinforcement accurately in position during concrete placement operations. Set wire ties so ends are directly away from exposed concrete surfaces.
5. At openings in structural slabs, provide two #4 bars top and bottom of slab at 45 degrees on all 4 corners, each bar 48 inch minimum length or per the structural sheet, whichever is greater.
6. At openings in concrete walls or slabs additionally provide a minimum of two #5 bars around opening.
7. Provide two #3 bars 3 inches apart on 4 sides of floor drains in slabs or per the structural sheet, whichever is greater.
8. Unless permitted by ENGINEER, reinforcing shall not be bent after being embedded in hardened concrete.
9. Suspend footing reinforcement in place with wires to assure proper placement. Where applicable, solid concrete bricks may be utilized to position reinforcement in spread and strip footings.

10. Welded wire fabric shall lap one full mesh at side and end laps and must be wired together. Mesh for slabs-on-grade shall be raised at least 2 inches during concrete pour. Minimum requirement for concrete toppings and slabs-on-grade shall be WWF 6x6 - W1.4 by W1.4 unless specifically noted otherwise on Drawings. Where indicated on Drawings, slab on grade reinforcement shall be supported on individual high chairs with sand plates for soil bearing (HCP). Supports shall be a minimum of 2 inches high and maximum spacing shall be 48 inches o.c. each way. Supports shall be tied to reinforcement.
11. Provide sufficient number of supports and sizes as required to carry reinforcement. Maximum spacing of chairs is 48 inches on center. Do not place reinforcing bars more than 2 inches beyond the last leg of any continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

B. WELDING OF REINFORCEMENT

1. Welding of reinforcement covered by this Section is prohibited.

5.0 WARRANTY

The PRODUCT and work shall be warranted against defects in material and workmanship for a period of one year. The warranty period shall begin after final inspection and acceptance by the project ENGINEER.

END OF SECTION

SUPPLEMENTAL SECTION 03 30 00

CAST IN PLACE CONCRETE

PART 1: GENERAL

1.0 SUMMARY

A. WORK INCLUDED

1. Include materials, labor, services, and incidentals necessary for completion of this section of Work.
2. Extent of cast-in-place concrete work is shown on Drawings.
3. Provide concrete bases for equipment of mechanical and electrical divisions. Coordinate size and location with HVAC, Plumbing, and Electrical CONTRACTORS.
4. Notify other trades of the date for concrete placement in ample time for each to install their own work.
5. Install anchor bolts, embedded plates, inserts and similar items furnished by other trades.

2.0 RELATED REQUIREMENTS

- A. Applicable provisions of Division 01 shall govern work of this Section.

3.0 NOTIFICATION

- A. CONTRACTOR shall notify the inspection/testing agency and ENGINEER at least 24 hours prior to major concrete pour.

4.0 PROTECTION OF ADJACENT WORK

- A. CONTRACTOR shall be responsible to see that due care is exercised to avoid staining adjacent finished material during concrete work. CONTRACTOR, without expense, shall make such damage good to OWNER.

5.0 REFERENCES AND DEFINITIONS

- A. Where all or part of a Federal, ASTM, ANSI, AWWA, Arizona Uniform Standard Specification for Public Works Construction etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.

B. DEFINITIONS:

6. American Concrete Institute (ACI):

- a) ACI 117: Standard Specifications for Tolerances for Concrete Construction and Materials
- b) ACI 301: Specifications for Structural Concrete
- c) ACI 350: Code Requirements for Environmental Engineering Concrete Structures
- d) Additional ACI sections are noted in later text.

7. American Society For Testing And Materials (ASTM):

- a) Specific ASTM standards are noted in later text.

6.0 SUBMITTALS

- A. General: Submit listed submittals in accordance with conditions of the Contract and with Specification 01 33 00.
- B. Product Data: Submit product data, including manufacturer's specifications, installation instructions, and general recommendations for installation. Also include manufacturer's certification or other data substantiating that products comply with requirements of Contract Documents. Clearly identify product/model to be used.
- C. Test Reports: Submit for acceptance, complete test reports from approved independent testing laboratories certifying that product conforms to performance characteristics and testing requirements specified herein.
- D. Shop drawings: Submit clear, concise drawing showing model number, size, arrangement and configuration of all products specified. Minimum sheet size is 8.5" X 11".

7.0 QUALITY ASSURANCE

A. Industry Standards, Specifications and Codes:

1. General:

- a) Comply with provisions of the following codes and standards except as modified herein.
- b) Referenced codes and standards including revisions and commentaries shall be the most currently adopted as of the date of these Contract Documents.

- 1. Sample fresh concrete to conform to ASTM C 172.

B. ALLOWABLE TOLERANCES

1. Flatwork tolerance for random-traffic floors should be measured in accordance with ASTM E 1155.
2. When area of slab surface within 2 feet of construction joints exceeds 25 percent of slab surface, entire surface area shall be tested, including those areas within 2 feet of construction joints.
3. Floor tolerance measurements shall be made within 16 hours after completion of final troweling operation, and where applicable, before removal of supporting shores.
4. Floor slabs shall conform to the following ACI F-number requirements:
 - a) Slab-On-Grade and Level Suspended Slabs Shored Until After Testing:
 - i. Specified Overall Values - FF30/FL20
 - ii. Minimum Local Values - FF15/FL10
 - b) Unlevel Shored Suspended Slabs and Unshored Suspended Slabs:
 - i. Specified Overall Value - FF25
 - ii. Minimum Local Value - FF15

See ACI 117 for other tolerances not stated herein.

C. Aggregate Tests:

1. Chloride content in aggregate shall be tested in accordance with ASTM D 1411. Tests shall be made and results must be approved by ENGINEER before the aggregate is used in concrete.

D. Slump:

1. In accordance with ASTM C 143. One slump test at point of discharge from ready mix truck for each set of test cylinders taken, unless noted otherwise, with additional tests when concrete consistency seems to have changed. If measured slump falls outside limits specified, a check test shall be made immediately on another portion of the same sample. In the event of a second failure, concrete will be considered to have failed to comply with Specifications. Slump tests, when taken, shall also be conducted after site addition of superplasticizer.

E. Air Content:

1. Only for air entrained concrete, in accordance with ASTM C 231 pressure method for normal weight concrete and ASTM C 173 for lightweight concrete. One air content test for each set of strength test cylinders made unless noted otherwise. If measured air content falls outside limits specified, a check test shall be made immediately on another portion of the same sample. In the event of a second failure, concrete will be considered to have failed to comply with Specifications. In compliance with ASTM C 94, site addition of additional air

entrainment admixture is permissible until plant adjustments have been made. For site added superplasticizer, air should only be checked after the addition of superplasticizer.

F. Concrete Temperature:

1. In accordance with ASTM C 1064 each time a set of compression test specimen is made.

G. Strength Tests:

1. Strength test for any class of concrete shall consist of 4 standard cylinders made from a composite sample secured from a single load of concrete in accordance with ASTM C 172, except when in the opinion of the ENGINEER, he may require additional specimens.

2. All Concrete:

- a) Make test cylinders in accordance with ASTM C 31. Each test shall consist of a minimum of 4 cylinders.
- b) After 24 hours, 4 cylinders to be carefully transported to testing laboratory for moist curing.
- c) 1 laboratory cured cylinder to be tested at 7 days and 2 laboratory cured cylinders to be tested at 28 days.
- d) 1 laboratory cured cylinder to be tested at 56 days if 28 day tested cylinders do not meet specified strength.
- e) A 5th laboratory cured cylinder shall be taken if the contractor intends to remove forms in 48 hours. Test cylinder shall be tested at 48 hours.

3. Maturity Methods:

- a) Maturity Methods acceptable as long as they are done in addition to standard cylinder strength tests completed in accordance with ASTM C 172 and are completed in order to facilitate decision making opportunities for construction operations.
- b) Shall be completed in compliance with ASTM C 1074 "Standard Practice for Estimating Concrete Strength by the Maturity Method".
- c) Any modifications to the mixture design (including but not limited to admixtures) or material sources shall be accompanied by a re-calibration of strength-maturity relationship, datum temperature and activation energy.

4. Test results at 28 days shall be the average strength of specimens determined in accordance with ASTM C 39.

5. Strength test shall be made per STS 01 21 19.
6. Strength of each concrete class shall be deemed satisfactory when both of the following criteria are met:
 - a) The average of three consecutive compressive-strength tests equals or exceeds specified compressive strength.
 - b) Any individual compressive-strength test result does not fall below specified compressive strength by more than 500 psi.
7. Testing shall be performed in compliance with Division 01 provisions by an approved testing laboratory at OWNER'S expense, which shall submit complete reports of tests to Construction Manager, Concrete Supplier, ENGINEER and OWNER'S representative. Reports of compressive strength tests shall contain project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, weather at time of placement and compressive breaking strength and type of break. An individual having ACI Level 1 Technician certification shall complete testing, including test cylinder production. Site protection of test cylinders shall be made in compliance with ASTM C 31.
8. If ENGINEER has reason to believe cylinder strength tests are not representative of strength of concrete in place, he shall require drilled cores to be cut and tested at CONTRACTOR'S expense. Coring and testing shall be in accordance with ASTM C 42 "Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete". Acceptance or rejection of concrete shall be based on cylinders made from concrete sampled at point of discharge. Impact hammer, sonoscope or other nondestructive device may be permitted, but shall not be used as the sole basis for acceptance or rejection.
9. Extent of Testing:
 - a) Class B: Air and slump tests shall be performed at a rate coinciding with strength tests. Test reports shall be sent to ENGINEER immediately upon completion.

8.0 STORAGE AND HANDLING

- A. The CONTRACTOR shall be responsible for the safe storage of the equipment until it is incorporated in the completed project.

PART 2: PRODUCTS

1.0 SPECIFICATIONS

- A. Hydraulic Cement:

1. For normal concrete, hydraulic cement shall meet requirements of ASTM C 150, ASTM C 595, or ASTM C 1157.
2. For air-entrained concrete, cement shall meet requirements of ASTM C 150, Type 1A Portland Cement or cement specified for normal concrete may be used with an air-entraining admixture conforming to ASTM C 260.

B. Slag Cement:

1. Slag cement shall not be used.

C. Silica Fume Cement:

1. Silica fume shall not be used.

D. Fly Ash:

1. Fly ash shall meet the requirements of ASTM C 618.

E. Aggregates:

1. Normal weight aggregate shall comply with requirements of ASTM C 33. Lightweight aggregates shall comply with requirements of ASTM C 330.

F. Water:

1. Water used for batching concrete shall meet the requirements of ASTM C 1602.

2.0 MATERIALS

A. ADMIXTURES

1. No other admixtures will be allowed except those listed without ENGINEER'S approval.
2. Air-Entraining:
 - a) Shall Conform to ASTM C 260, certified by the manufacturer to be compatible with other required admixtures. The Entrained air content shall be controlled at 6½ percent for ¾" aggregate concrete and 5½ percent for 1½" aggregate concrete within limits of plus or minus 1½ percent each.
 - b) Products: Subject to compliance with requirements, provide one of the following:
 - i. "Darex II" – W.R. Grace
 - ii. "AEA 92S" - Euclid
 - iii. "Catexol AE 260" – Axim Concrete Technologies
 - iv. "Micro-Air" – BASF Admixtures, Inc.

- v. "MB AE 90" – BASF Admixtures, Inc.

3. Water Reducing:

- a) Shall conform to ASTM C 494, Type A
- b) Products: Subject to compliance with requirements, provide one of the following:
 - i. "WRDA 82" – W.R. Grace
 - ii. "Eucon WR-91" - Euclid
 - iii. "Catexol 1000N" – Axim Concrete Technologies
 - iv. "Pozzolith 200N" – BASF Admixtures, Inc.

4. Mid-Range Water Reducing:

- a) Shall conform to ASTM C 494, Type A or Type F
- b) Products: Subject to compliance with requirements, provide one of the following:
 - i. "Daracem 65" – W.R. Grace
 - ii. "Eucon MR" - Euclid
 - iii. "Catexol 3500N" – Axim Concrete Technologies
 - iv. "Polyheed 997" - BASF Admixtures, Inc.

5. High-Range Water Reducing (Super Plasticizer):

- a) Shall conform to ASTM C 494, Type F or Type G.
- b) Products: Subject to compliance with requirements, provide one of the following:
 - i. "Daracem 19" - W.R. Grace & Co.
 - ii. "ADVA 100" - W.R. Grace & Co.
 - iii. "Eucon 37" - Euclid
 - iv. "Catexol 1000SP-MN" – Axim Concrete Technologies
 - v. "Rheobuild 1000" - BASF Admixtures, Inc.

6. Water Reducing, Non-Chloride Accelerator:

- a) Shall conform to ASTM C 494, Type C or Type E.
- b) Products: Subject to compliance with requirements, provide one of the following:
 - i. "Polarset" - W.R. Grace & Co.
 - ii. "Accelguard 80" - Euclid Chemical Co.
 - iii. "Catexol 2000RHE" – Axim Concrete Technologies

iv. "Pozzutec 20" - BASF Admixtures, Inc.

7. Water Reducing, Retarding:

- a) Shall conform to ASTM C 494, Type D.
- b) Products: Subject to compliance with requirements, provide one of the following:
 - i. "Daratard 17" - W.R. Grace & Co.
 - ii. "Eucon Retarder 100" - Euclid Chemical Co.
 - iii. "Catexol 1000R" – Axim Concrete Technologies
 - iv. "Pozzolith 100XR" - BASF Admixtures, Inc.

B. BONDING AGENT

- 1. Shall be a poly-vinyl acetate emulsion.
- 2. Products: Subject to compliance with requirements, provide one of the following:
 - a) "Southcrete 45" – SGM
 - b) "Euco Weld" – Euclid Chemical Company

C. RELATED MATERIALS

- 1. Evaporation Retardant and Finishing Aid: Shall be "Confilm" by BASF Admixtures, Inc.
- 2. Stair Nosings: Provide single component safety tread stair nosings, Type 231 on interior and exterior stairs, as manufactured by Wooster Products, Inc., Wooster, Ohio, Style AXPE by Safe-T-Metal Company or approved equal, unless indicated otherwise on Project Drawings.
- 3. Waterstops: Provide flat, dumbbell type or center bulb PVC type waterstops at construction joints and other joints as indicated or otherwise detailed on Drawings. Size to suit joints. Waterstops shall be a minimum of 6 inches wide and suitable for use intended. Splices shall be made with hot splicing iron recommended by manufacturer and shall conform to Corp of ENGINEER'S CRD-C 572.
 - a) Products: Subject to compliance with requirements, provide products of one of the following:
 - i. AFCO Products
 - ii. The Burke Co.
 - iii. Edoco Technical Products
 - iv. Greenstreak Plastic Products
 - v. Harbor Town Products
 - vi. W.R. Meadows

vii. Vinylex Corp.

4. Slab-On-Grade and Composite Steel Floor Deck Poly Fiber Reinforcement Systems:

a) Synthetic Structural Fiber Reinforcement: Provide synthetic structural fibers complying with the following requirements:

- i. Synthetic structural fibers shall meet requirements of ASTM C 1116, Paragraph 4.1.3, Type III.
- ii. Synthetic structural fibers shall be monofilament, made of polypropylene or polypropylene/polyethylene blend.
- iii. Synthetic structural fibers shall have a minimum length of 1.38 inches (35 mm) and a maximum length of 2.00 inches (51 mm).
- iv. Specific gravity between 0.90 and 0.95
- v. Synthetic structural fibers shall have an aspect ratio (length divided by equivalent diameter of fiber) between 60 and 100.
- vi. Dosage rate:

1) Composite Steel Floor Deck Systems: 4.0 lbs/cubic yard for replacement of 6" x 6" - W1.4 x W1.4 and 6" x 6" - W2.1 x W2.1 WWF; 5.0 lbs/cubic yard for replacement of 6" x 6" - W2.9 x W2.9 WWF

2) Slab-On-Grades: 5.0 lbs/cubic yard or the addition rate to achieve the concrete required minimum equivalent flexural strength, f_{e3} of 165 psi for a concrete with a compressive strength of 4,000 psi at 28 days. This shall be determined from the manufacturer's test data verifying fiber performance in concrete based on ASTM C1609-05, utilizing the beam size 6" x 6" x 20" (f_{e3}) calculated using JCI-SF4 method.

vii. Synthetic structural fibers shall be:
Grace STRUX® 90/40 synthetic fiber
Novomesh® 950 synthetic fiber by Propex Concrete Systems
Tuf-Strand SF by Euclid Chemical Company

5. Slab-On-Grade Steel Fiber Reinforcement System:

a) Shall be ASTM A 820, Type I cold drawn high tensile deformed steel wire

- i. Minimum length of 1.50 inches (38 mm) and a maximum length of 2.00 inches (51 mm)
- ii. Equivalent diameter 0.039 inches
- iii. Tensile strength 152,000 psi
- iv. Dosage rate to be 35 pounds per cubic yard of concrete
- v. Steel fibers shall be:

1) Novocon® 1050 steel fibers by Propex Concrete Systems

6. Slab-On-Grade Poly/Steel Fiber Reinforcement System:

- a) Shall be a blend of steel fiber and 100 percent virgin homopolymer polypropylene graded multifilament fiber containing no reprocessed olefin materials complying with ASTM C 1116, Paragraph 4.1.3, Type III and ASTM A 820. Dramix Duo 150 or Novomesh 850 at a dosage rate of 36 pounds per cubic yard of concrete or equal (submit 'or equal' product for acceptance).

i. Chemical and Physical Properties Polypropylene Component:

- | | | |
|---------------------|------|------------------------|
| 1) Absorbtion | | Nil |
| 2) Specific Gravity | 0.91 | |
| 3) Fiber Length | | Multi-Design Gradation |
| 4) Melt Point | | 324 degrees F |

ii. Steel Component

- | | |
|--------------------------------|---|
| 1) Tensile Strength | 140 – 180 ksi |
| 2) Fiber Length | 1.5 inches to 2.0 inches (38 mm to 51 mm) |
| 3) Average Equivalent Diameter | 0.035 inches to 0.045 inches |

- b) Moisture Barrier: Provide moisture barrier over prepared base course. Use only materials resistant to decay when tested in accordance with ASTM E 154, as follows:

- i. Polyethylene sheet not less than 10 mils thick with a permeance of less than 0.3 US perms as determined by ASTM E96. Place over compacted granular base.

- c) Vapor Retarder: Provide vapor retarder over prepared base course. Provide manufacturer's recommended pipe boots, mastics and gusset tape. Use only materials resistant to decay when tested in accordance with ASTM E 154, as follows:

i. Vapor Retarder membrane must have the following qualities;

- | | |
|------------------------------------|--------------------------------------|
| 1) Maximum Permeance | ASTM E 96 0.04 Perms |
| 2) Water Vapor Retarder | ASTM E 1745 Meets or exceeds Class C |
| 3) Thickness of Retarder (plastic) | Not less than 10 mils |

ii. Provide one of the following:

- 1) Stego Wrap (10 mil) Vapor Barrier by Stego Industries LLC
- 2) Griffolyn T-85 by Reef Industries
- 3) Moistop Ultra by Fortifiber Industries

- 4) W.R. Meadows Perminator 10 mil vapor retarder
- d) Vapor Barrier: Provide vapor barrier over prepared base course. Provide manufacturer's recommended pipe boots, mastics and gusset tape. Use only materials resistant to decay when tested in accordance with ASTM E154, as follows:
 - i. Vapor Barrier membrane must have the following qualities;
 - 1) Water Vapor Transmission Rate ASTM E 96 less than 0.008
 - 2) Water Vapor Barrier ASTM E 1745 Class A
 - ii. Provide one of the following:
 - 1) Stego Wrap (15 mil) Vapor Barrier by Stego Industries LLC
 - 2) W.R. Meadows Perminator 15 mil vapor barrier
 - 3) Zero-Perm by Alumiseal

7. Slab-On-Grade Granular Choker/Protection Course:

- a) Provide a 1 inch (maximum) choker course over granular base course and as a 3 inch thick layer between barrier/retarder and concrete slabs-on-grade where specifically referenced:
 - i. Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a No. 4 sieve and 10 to 30 percent passing a No. 100 sieve; meeting deleterious substance limits of ASTM C 33 for fine aggregates.

8. Non-Shrink Grout:

- a) Factory pre-mixed non-metallic grout, complying with ASTM C 1107.
 - i. Products: Subject to compliance with requirements, provide one of the following:
 - 1) "Set Grout" - ChemRex
 - 2) "Sonogrout" - Sonneborn
 - 3) "Euco-NS" - Euclid Chemical Co.
 - 4) "Sealtight 588" - W.R. Meadows
 - 5) "Crystex" - L&M Cons. Chemical Co.
 - 6) "Sure-Grip Grout" - Dayton Superior Corp.
 - 7) "Horngrout" - A.C. Horn
 - 8) "Five Star Grout" - US Grout Corp.

9. Absorptive Cover:

- a) Burlap cloth made from jute or Kenaf, weighing approximately 9 ounces per square yard, complying with AASHTO M182, Class 2.

10. Moisture-Retaining Cover:

- a) One of the following, complying with ASTM C 171, Type 1 or 2:
 - i. Polyethylene Film
 - ii. Polyethylene Coated Burlap

11. Liquid Membrane-Forming Curing Compound:

- a) Liquid type membrane-forming curing compound complying with ASTM C 1315 "Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete", Type I, Class A unless other type acceptable to Architect. Moisture loss not more than 0.040 gr./square cm. In 72 hours when applied at 300 sq. ft./gal. Material must be compatible with resilient flooring and carpeting adhesives. Concrete CONTRACTOR shall verify compatibility before applying curing compound.
 - i. Products: Subject to compliance with requirements, provide one of the following:
 - 1) "Masterseal" - Master Builders
 - 2) "Kure-N-Seal" - Sonneborn
 - 3) "Tri-Kote 18 Clear CRECT" - TK Products, Inc.
 - 4) "Cure and Seal" - Symons Corp.

12. Liquid Membrane-Forming Curing Compound on Silica-Fume Concrete:

- a) Resin based, white pigmented solvent complying with ASTM C 309, Type 2, Class B. Water curing of silica-fume concrete is standard with this curing compound being used only where approved by ENGINEER.
 - i. "Resi-Chem White" - Symons Corp.
 - ii. "L&M Cure R-2" – L&M Construction Chemicals

13. Epoxy Adhesive: ASTM C 881, 2 component material suitable for use on dry or damp surfaces. Provide material "Type", "Grade", and "Class" to suit project requirements.

- a) Products: Subject to compliance with requirements, provide one of the following:
 - i. "Concresive LPL Liquid" - ChemRex
 - ii. "Epoxtite" - A.C. Horn
 - iii. "Edoco 2118 Epoxy Adhesive" - Edoco Technical Prod.
 - iv. "Sikadur Hi-Mod" - Sika Chemical
 - v. "Euco Epoxy 452" - Euclid Chemical Co.

- vi. "Patch and Bond Epoxy" - The Burke Co.
- vii. "Sure-Poxy" - Kaufman Products, Inc.

14. Sealer: Where concrete floors, new or existing call for "Sealer" in Room Finish Schedule, the following material shall be applied by licensed applicator. Furnish 5 year written guarantee.
15. Armorseal Floor-Plex 7100, a 2-part water-based epoxy floor coating, manufactured by the Sherwin Williams Company, or approved substitute.
16. Non-slip Aggregate Finish: For stairs, landings, platforms and where otherwise noted, provide fused aluminum oxide grits, or crushed emery, as abrasive aggregate for non-slip finish with emery aggregate containing not less than 40 percent aluminum oxide and not less than 25 percent ferric oxide. Use material that is factory-graded, packaged, rust-proof, and non-glassing, and is unaffected by freezing, moisture, and cleaning materials. Submit samples for Architect's approval.
 - a) Products: Subject to compliance with requirements, provide one of the following:
 - i. "Frictex" - Sonneborn
 - ii. "Euco-Non-Slip" - Euclid Chemical Co.
17. Isolation Joint Filler: Shall be bituminous (1/2 inch and ¼ inch thicknesses) conforming to ASTM D 994.
18. Control Joint Insert: Shall be hardboard or fiberboard.
19. Expansion Joint Filler: Shall be extruded polystyrene.
20. Underlayment Compound: Freeflowing, self-leveling, pumpable, cement-based compound for applications from 1-1/2 inch thick to feathered edges, minimum strength of 4000 psi.
21. Products: Subject to compliance with requirements, provide one of the following:
 - a) "Level-Right Plus" – Maxxon Great Lakes
 - b) "K-15" – Ardex, Inc.
 - c) "Stonecrete UL1" – Stonehard, Inc.
 - d) "Thoro SLU" – Thoro System Products
22. Dovetail Anchor Slots: Shall be #305 Hohman and Barnard, Inc. or equivalent 20 gage sheet metal in Eraydo Zinc with felt strip protector.

D. READY MIXED CONCRETE

1. Ready mixed concrete shall be measured, mixed and delivered according to ASTM C94, except as modified herein.
2. Prepare design mixtures for each class of concrete on the basis of laboratory trial mixtures or field test data, or both in accordance with ACI 301. Design mixtures shall meet the

requirements listed in General Structural Notes.

3. Addition of water is permitted at the job site but is limited to the quantity of water indicated on the delivery ticket such that the mixing water content on approved mix design is not exceeded.
4. As a quality control measure of this Specification, walls and floor mix designs shall be verified for air and strength requirements by placing concrete mix for footing elements prior to placing concrete at its designated location.
5. Ready Mixed Concrete Delivery Tickets:
 - a) Furnish 2 delivery tickets with each batch of concrete before unloading at site; 1 for CONTRACTOR and 1 for ENGINEER on which is printed, stamped or written the following information:
 - i. Name of ready-mix batch plant
 - ii. Serial number of ticket
 - iii. Date and truck number
 - iv. Name of Contractor
 - v. Job name and location
 - vi. Specific class or designation of concrete
 - vii. Amount of concrete (cubic yards)
 - viii. Time loaded or of first mixing of cement and aggregates
 - ix. Type, name and amount of admixture
 - x. Type, brand and amount of cement
 - xi. Total water content by producer (or W/C ratio)
 - xii. Maximum size of aggregate
 - xiii. Weights of fine and coarse aggregates

2.0 PRE-APPROVED MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work, include, but are not limited to, the following:
 1. As noted throughout this section.
- B. Substitutions /or Equal: If alternative manufacturers other than the pre-approved manufacturer are proposed for any specified equipment in this section, the CONTRACTOR/bidder must supply a submittal, refer to STS 01 33 00.
- C. Although the brands listed herein are the preferred brands, it is not the intent of the OWNER for these specifications to be proprietary; equals will be evaluated in accordance with comparable quality, construction, strength, durability, and suitability for the purpose intended and are listed for the purpose of describing the standard of quality performance and characteristics.
- D. Manufacturers listed in this specification do not constitute approval. All equipment must have the capabilities and functions as specified herein.

PART 3: EXECUTION

1.0 CONTRACTOR'S RESPONSIBILITY

- A. The CONTRACTOR is responsible for furnishing and installing the PRODUCT including all site preparation, and other items necessary for the proper installation and operation of the PRODUCT.

2.0 EXAMINATION

- A. Examine all products for compliance with this section.
- B. Proceed with installation only after unsatisfactory conditions have been corrected

3.0 PREPARATION

- A. Clean all mixing and transportation equipment. Wet forms thoroughly. Remove all ice, excess water, mud and other debris from within forms and from reinforcement. Notify ENGINEER prior to placing in ample time for inspection of forms and reinforcing.
- B. A pre-construction meeting of A/E, Concrete CONTRACTOR, Construction Manager/General CONTRACTOR, Concrete Supplier and OWNER'S representative shall take place prior to placing elevated structural slabs. Topic of discussion shall include: concrete handling, placing, finishing and curing.

4.0 INSTALLATION

A. PLACEMENT OF CONCRETE

2. Pre-Placement Inspection:

- a) Before placing concrete, inspect and complete formwork installation, reinforcing steel and items to be embedded or cast-in-place. Notify other CONTRACTORS to permit installation of their work; cooperate with other trades in setting such work as required. Thoroughly wet wood forms immediately before placing concrete as required where form coatings are not used. Notify inspection agency and ENGINEER 24 hours in advance of pouring.

3. Placing Concrete In Forms:

- a) Deposit concrete in forms in horizontal layers not deeper than 18 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints. Maximum length of wall pour is 100 feet between construction joints. Maximum length of wall pour for liquid-containing structures is 60 feet between construction joints.
- b) Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If a section cannot be placed

continuously, provide construction joints as specified. Deposit concrete as nearly as practicable to its final location to avoid segregation due to re-handling or flowing.

- c) Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use vibrators designed to operate with vibratory element submerged in concrete, maintaining a speed of not less than 6000 impulses per minute. Alternate methods of consolidating concrete including the use of self-consolidating concrete may be submitted to the ENGINEER for approval.
- d) Do not use vibrators to move concrete inside of forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

4. Placing Concrete Slabs:

- a) Deposit and consolidate concrete slabs in a continuous operation until placing of a panel or section is completed.
- b) Place interior slabs on grade using long-strip construction techniques or other approved method.
- c) Place suspended slabs in sections as large as practicable to complete finishing, within limits acceptable to ENGINEER.
- d) Consult with ENGINEER with regard to limits of single placements prior to commencing work.
- e) Consolidate concrete during placing operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
- f) Bring slab surfaces to correct level with a straightedge and strikeoff. Use bull floats or darbies to smooth surface, leaving it free of humps or hollows. Do not sprinkle water on plastic concrete surface. Do not disturb slab surfaces prior to beginning finishing operations. "Wet Screed" placement of slabs is not allowed.
- g) Maintain reinforcing in the proper position during concrete placement operations. Welded wire fabric per STS 03 21 13.

5. Cold Weather Placing:

- a) Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions or low temperatures in compliance with ACI

301.

- b) Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
- c) Do not use calcium chloride, salt or other materials containing anti-freeze agents or chemical accelerators other than approved, non-chloride accelerating admixtures.
- d) Do not allow carbon dioxide from heating units to contact freshly placed concrete surfaces for 48 hours. Vent heaters outside of enclosure.

6. Hot Weather Placing:

- a) When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 301.
- b) Wet forms thoroughly before placing concrete.
- c) Do not use retarding admixtures without the written permission of the ENGINEER.

B. CONCRETE JOINTS

1. Construction Joints:

- a) Locate as directed by ENGINEER or as shown on Drawings. Form keyway. Place perpendicular to main reinforcement. Continue reinforcement through joint. Locate joint so as not to affect structural integrity or appearance of the structure. Includes joint between wall and footing.

2. Isolation Joints:

- a) Form with keyway with bituminous (preformed filler, 1/4 inch or 1/2 inch (as called for) thick full depth of slab-on-grade. Reinforcement is non-continuous. Locate at points of contact between slab-on-grade and vertical structural concrete.

3. Control Joints:

- a) Locate on grid lines or on lines as shown on Drawings or as directed by ENGINEER. Joint size shall be 1/4 inch wide by 1/5 to 1/4 of slab depth. Continue reinforcement through joint. CONTRACTOR'S option to tool or use insert. Do not tool joints in slabs to receive a finished flooring material. Control joints should be made within first 24 hours of concrete pour.

C. FINISHING

1. General:

- a) Strike and level concrete. Allow to set before floating. Power float on disappearance of water sheen. Hand float areas inaccessible to power float. Applicable to flat work to obtain smooth, uniform, granular texture. Floors shall be flat and level within tolerances given in Part 1, except where drains occur or sloped floors are indicated, in which case tolerance applies to planes indicated.

2. Troweled Finish:

- a) Power trowel to smooth finish. Hand trowel areas inaccessible to power trowel. Applicable to flatwork to receive finished flooring material.

3. Broom Finish:

- a) Draw broom across surface after floating to form a regular, parallel pattern. Applicable to parking ramps, drives, ramps and stairs. Direction of brooming shall be perpendicular to traffic pattern.

4. Formed Concrete:

- a) Top of concrete: Strike concrete smooth then float and trowel surface to texture comparable to formed surface.
- b) Formed Surface: As cast finish, patch holes and defects after form removal. Remove fins.
- c) Rubbed Surface: Rub with rubbing stone to remove all projections and round corners. Wet surface and brush evenly with cement grout mixture. Provide rubbed concrete surfaces in finished areas to be left to view in stairwells, where concrete is exposed to view in a finished area and wherever else a rubbed surface is called for on architectural plans.
- d) Slope exterior steps down 1/8 inch.

5. Exterior Walks:

- a) Broom finish unless otherwise indicated. After floating, troweling and when water sheet has disappeared, brush lightly with approved steel or fiber broom not less than 18 inches wide at right angles to centerline to form a uniform roughened surface. Edge panel joints with metal tool to leave smooth border around each panel.

6. Non-Slip Finish:

- a) Apply to exterior concrete stair treads, stair platforms, sloped walks and elsewhere as indicated. After floating, surface shall be given a "dry shake" application of crushed ceramically bonded aluminum oxide. Rate of application

of such material shall be not less than 25 pounds per 100 square feet. Tamp aggregate flush with surface using a steel trowel but do not force below surface. After broadcasting and tamping, apply trowel finishing as specified.

D. CURING

1. Comply with ACI 301.
2. Class A Concrete Curing:
 - a) Concrete items listed below shall be water cured per ACI 308.2.2 only for 5 days after placement. Curing system must be monitored and additional moisture added as required. During curing period surfaces of concrete surface shall be wet.
 - b) Concrete requiring this class of curing includes all slabs on grade (slab on grades placed where ambient temperature is below freezing may be cured by Class C curing methods).
3. Class B Concrete Curing:
 - a) Concrete items listed below shall be sheet cured per ACI 308 2.3.1 Plastic Film or 2.3.2 Reinforced Paper only, for 7 days after placement. Curing system joints shall be sealed and moisture added daily to maintain concrete surface in a damp condition. Insulating blankets used during cold weather do not need sealed joints as long as concrete surface is damp. During cold weather (below 50 degrees F), curing may be terminated after stressing for post-tensioned elements.
 - b) Concrete requiring this class of curing includes parking deck slabs, suspended structural slab, selected slab on grade, and liquid containing structures.
4. Class C Concrete Curing:
 - a) Concrete surfaces not specified to receive other curing shall be liquid membrane cured per ACI 308 2.3.3. If no rate of coverage is indicated by manufacturer, apply at a uniform rate of 200 square feet per gallon. Maximum rate of coverage, even if manufacturer's recommendation indicated greater coverage, shall be 300 square feet/gallon.
5. Formed Surfaces:
 - a) Cure formed concrete surfaces including walls, columns, underside of beams, supported slabs and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by membrane curing.

6. Protection:

- a) Protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration, and from damage caused by rain or flowing water. Protect finished concrete surfaces from damage by subsequent construction operations.

E. REPAIRING AND PATCHING

1. Concrete Surface Repairs:

- a) Comply with ACI 301 "Specifications for Structural Concrete".
- b) Remove and replace, at no additional cost, concrete not formed as shown on Drawings, concrete out of alignment, surfaces beyond required tolerances or defective surfaces which cannot be properly repaired or patched, including concrete failing to meet strength requirements as determined by testing laboratory.
- c) Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Architect. Cut out honeycomb, rock pockets, voids over 1/4 inch in any dimension, and holes left by tie rods and bolts, down to solid concrete but, in no case to a depth of less than 1 inch. Make edges of cuts perpendicular to concrete surface. Thoroughly clean, dampen with water and brush coat area to be patched with specified bonding agent. Place patching mortar after bonding compound has dried.
- d) For exposed to view surfaces, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.
- e) Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on surface and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes, fill with dry pack mortar or precast cement cone plugs secured in place with bonding agent.
- f) Repair concealed formed surfaces, where possible, that contain defects that affect durability of concrete. If defects cannot be repaired, remove and replace concrete.
- g) Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces

sloped to drain for trueness of slope, in addition to smoothness, using a template having required slope.

- h) Repair finished unformed surfaces that contain defects that affect durability of concrete. Surface defects, include crazing, cracks in excess of 0.01 inch wide or which penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling, popouts, honeycomb, rock pockets and other objectionable conditions.
- i) Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days.
- j) Correct low areas in unformed surfaces during, or immediately after, completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary leveling compounds may be used when acceptable to Architect.
- k) Repair defective areas, except random cracks and single holes not exceeding 1 inch diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4 inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
- l) Repair isolated random cracks and single holes not over 1 inch in diameter by dry-pack method. Groove top of cracks and cut out holes to sound concrete and clean of dust, dirt and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of 1 part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry-pack after bonding compound has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.
- m) Do not use repair methods not specified above and do not perform structural repairs, except with prior written approval of Architect for method and procedure, using specified epoxy adhesive mortar.

5.0 WARRANTY

- A. The PRODUCT and work shall be warranted against defects in material and workmanship for a period of one year. The warranty period shall begin after final inspection and acceptance by the project ENGINEER.

END OF SECTION

SUPPLEMENTAL SECTION 04 05 16

MASONRY GROUTING

PART 1: GENERAL

1.0 SUMMARY

- A. Include materials, labor, services and incidentals necessary for completion of this Section of Work.
- B. Extent of masonry work is indicated on Drawings.
- C. Applicable provisions of Division 01 shall govern work of this Section.

2.0 REFERENCES AND DEFINITIONS

A. Industry Standards, Specifications and Codes:

1. General:

- a) Comply with provisions of the following codes and standards except as modified.
- b) Referenced codes and standards, including revisions and commentaries, shall be the most currently adopted as of the date of these Contract Documents.

2. American National Standards Institute (ANSI):

- a) A41.1 Building Code Requirements for Masonry

3. American Society for Testing and Materials (ASTM):

- a) Additional Specific ASTM numbers are noted in later text

4. American Concrete Institute (ACI):

- a) ACI 530-05 Building Code Requirement for Masonry Structures
- b) ACI 530.1-05 Specifications for Masonry Structures

5. National Concrete Masonry Association (NCMA)

6. The Brick Institute Of America (BIA)

- B. Where all or part of a Federal, ASTM, ANSI, AWWA, and Arizona Uniform Standard Specification for Public Works Construction etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.

3.0 SUBMITTALS

- A. General: Submit listed submittals in accordance with conditions of the Contract and with Specification 01 33 00.
- A. Product Data: Submit product data, including manufacturer's specifications, installation instructions, and general recommendations for installation. Also include manufacturer's certification or other data substantiating that products comply with requirements of Contract Documents. Clearly identify product/model to be used.
- B. Test Reports: Submit for acceptance, complete test reports from approved independent testing laboratories certifying that product conforms to performance characteristics and testing requirements specified herein.
- C. Shop drawings: Submit clear, concise drawing showing model number, size, arrangement and configuration of all products specified. Minimum sheet size is 8.5" X 11".

4.0 QUALITY ASSURANCE

A. Tolerances

1. Dimension of Elements:

- a) In Cross Section or Elevation: minus 1/4 inches, plus 1/2 inches
- b) Mortar Joint Thickness:
 - i. Bed Joint: plus/minus 1/8 inches
 - ii. Head Joint: minus 1/4 inches, plus 3/8 inches
 - iii. Collar: minus 1/4 inches plus 3/8 inches
- c) Grout space or cavity width, except for masonry walls passing framed construction: minus 1/4 inches, plus 3/8 inches

2. Elements:

- a) Variation from Level:
 - i. Bed Joints: plus/minus 1/4 inches in 10 feet, plus/minus 1/2 inches maximum
- b) Top Surface of Bearing Walls: plus/minus 1/4 inches in 10 feet, plus/minus 1/2 inches maximum

- c) Variation from Plumb: plus/minus 1/4 inches in 10 feet, plus/minus 3/8 inches in 20 feet, plus/minus 1/2" maximum
- d) True to a Line: plus/minus 1/4 inches in 10 feet, plus/minus 3/8" inches in 20 feet, plus/minus 1/2" maximum
- e) Alignment of Columns and Walls (bottom versus top):
- f) Bearing Walls: plus/minus 1/2 inches
- g) Non- Bearing Walls: plus/minus 3/4 inches

3. Location of Elements:

- a) Indicated in Plan: plus/minus 1/2 inches in 20 feet, plus/minus 3/4 inches maximum
- b) Indicated in Elevation: plus/minus 1/4 inches in story height, plus/minus 3/4 inches maximum

5.0 STORAGE AND HANDLING

- A. The CONTRACTOR shall be responsible for the safe storage of the equipment until it is incorporated in the completed project.
- B. Mortar materials and sand shall be stored in a manner to prevent deterioration or contamination by foreign material.

PART 2: PRODUCTS

1.0 SPECIFICATIONS

A. MORTAR AND GROUT MATERIALS

1. Portland Cement:

- a) Shall conform to ASTM C-150, Type I or Type II, except Type III may be used for cold weather protection. Only one brand and kind of Portland cement from one source shall be used for the work. Brands are subject to approval based on mortar color desired.

Hydrated Lime:

- b) Shall be pressure hydrated non-air entrained and conform to ASTM C-207, Type S.

2. Mortar Sand:

- a) Shall be either natural or manufactured clean, free from loam, silt, vegetable matter, salts and other injurious substances and shall conform to ASTM C-144 except that 100 % of sand for mortar in joints 1/4 inches or less shall pass a No. 16 sieve. Sand is further subject to approval of A/E based on mortar color desired and obtainable by use of local sands readily available. Sand shall be from one source.
3. Mortar Aggregate:
- a) Shall conform to ASTM C-144 as modified by BIA Technical Notes 8A, Article 4.3.
4. Grout Aggregate:
- a) Shall conform to ASTM C-404.
5. Water:
- a) Shall be obtained from a drinking supply source clean and free of deleterious amounts of oils, acids, alkali, salts, organic materials or other substances that are deleterious to mortar or other metal in wall and handled in clean containers.
6. Combination Plasticizer/Water-Repellent/Efflorescence Control Admixture:
- a) Shall be "Rheomix 825" by Degussa Admixtures division of Master Builders, Inc., "Hydrocide Powder" by Sonneborn Building Products, "OPTEC EC-255" by W.R. Grace and Company, or approved non-air entraining product. Use shall be in accordance with manufacturer's printed instructions.
7. Mortar Pigments:
- a) Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.
 - b) Approved products include Bayferrox Iron Oxide Pigments by Bayer Corporation Industrial Chemicals Division, True Tone Mortar Colors by Davis Colors, SGS Mortar Colors by Solomon Grind-Chem Services, Inc.
8. Other Admixtures:
- a) Shall not be used at anytime and will not be knowingly approved. Use of air entraining admixtures, chlorides or nitrates, with or without approval, will be sufficient cause to require removal and replacement of masonry work containing or treated with same.
9. Mortar Mixes:
- a) Measure materials for mortar by volume in a manner whereby proportions can

be controlled within 2 percent. Mix cementitious materials, powdered admixtures and masonry sand dry. Add admixtures in solution and water to bring to proper consistency for use. Mix materials in approved type machine mixer of adequate capacity for a minimum time of 5 minutes after materials have been introduced and until materials are evenly distributed throughout batch and mixture is uniform in color and consistency.

- b) Proportion Specification: Proportions listed below with 2 figures given are (Portland cement: Hydrated Lime). Hydrated lime may be listed giving a range rather than specific proportion:
 - i. Type 1: Mortar for exterior walls and load bearing partitions: Shall conform to ASTM C-270, Type S (Cement-Lime) Mortar. (1: 1/4 to 1/2)
 - ii. Type 2: Mortar for walls below grade: Shall conform to ASTM C-270, Type M (Cement-Lime) Mortar. (1: 1/4)
 - iii. Type 3: Mortar for interior non-load bearing partitions: Shall conform to ASTM C-270, Type N (Cement-Lime) Mortar. (1: 1/2 to 1 1/4)
- c) Aggregate proportion (measured in damp loose conditions) for each of 3 types shall not be less than 2 1/4 and not more than 3 times the sum of separate volumes of cementitious materials.
- d) Mortars of known higher strength shall not be indiscriminately substituted where a mortar type of anticipated lower strength is specified.

10. Masonry Grout Mixes;

- a) Proportion Specification:
- b) The proportions listed below with two figures given are (Portland cement: Hydrated Lime: Fine Aggregate: Course Aggregate). Hydrated lime and aggregate may be listed giving a range rather than specific proportion:
 - i. Fine Grout: Shall conform to ASTM C-476 - (1: 0 to 1/10 : 2 1/4 to 3 : 0)
 - ii. Course Grout: Shall conform to ASTM C-476 - (1: 0 to 1/10 : 2 1/4 to 3 : 1 to 2)
 - iii. Aggregate proportion (measured in damp loose conditions) times the sum of the separate volumes of cementitious materials.

2.0 MATERIALS

A. MORTAR

1. Cementitious materials and aggregates shall be stored in a manner to prevent deterioration or intrusion of foreign material.

2. Required portions of mortar materials shall be controlled and accurately measured.
3. Cementitious materials and aggregate shall be mixed between 3 and 5 minutes in a mechanical batch mixer with maximum amount of water to produce a workable consistency. Hand mixing of mortar is permitted with written approval of A/E.
4. Mortars that have stiffened shall be retempered by adding water as frequently as needed to restore required consistency. No mortars shall be used beyond 2 1/2 hours after mixing.

B. MASONRY GROUT

1. Grout shall be produced according to one of the following methods:

a) Materials Mixed at Job Site:

- i. Individual cementitious materials and aggregates stored at Job Site shall be mixed in a mechanical mixer for a with water to achieve desired consistency
- ii. Individual dry ingredients transported to Job Site in compartments shall be mixed with water at Job Site using continuous volumetric proportioning equipment to achieve desired consistency. Mix with an auger of appropriate length to provide adequate mixing.

b) Mixed Materials Transported to Job Site:

- i. Factory dry-blended cementitious materials and aggregates delivered to Job Site shall be mixed in a mechanical mixer for a minimum of 5 minutes with water to achieve desired consistency.
- ii. Wet-mixed grout shall arrive at Job Site in a ready-mixed condition. Slump shall be adjusted to specification and grout shall be re-mixed at a mixing speed for at least 1 minute before discharging to achieve desired consistency.
- iii. Place grout within 1 1/2 hours from introducing water in mixture and prior to set.
- iv. Grout maximum pour heights are as follows:

Grout Type	Pour Height	Grout Space, inches (For Grouting Between Masonry Wythes)	Dimensions for Grouting Cells of Hollow Units
Fine	1'-0"	¾"	1 ½" x 2"
Fine	5'-0"	2"	2" x 3"
Fine	12'-0"	2 ½"	2 ½" x 3"
Fine	24'-0"	3"	3" x 3"
Coarse	1'-0"	1 ½"	1 ½" x 3"
Coarse	5'-0"	2"	2 ½" x 3"
Coarse	12'-0"	2 ½"	3" x 3"

Manufacturers listed in this specification do not constitute approval. All equipment must have the capabilities and functions as specified herein.

PART 3: EXECUTION

1.0 CONTRACTOR'S RESPONSIBILITY

- A. The CONTRACTOR is responsible for furnishing and installing the PRODUCT including all site preparation, and other items necessary for the proper installation and operation of the PRODUCT.

2.0 EXAMINATION

- A. Examine all products for compliance with this section.
- B. Proceed with installation only after unsatisfactory conditions have been corrected

3.0 PREPARATION

- A. Verify items provided by other sections of work are properly sized and located.
- B. Establish lines, levels and coursing. Protect from disturbance.
- C. Provide temporary bracing during erection of masonry work. Maintain in place until building structure provides permanent bracing.

4.0 INSTALLATION

This section not used.

5.0 WARRANTY

The PRODUCT and work shall be warranted against defects in material and workmanship for a period of one year. The warranty period shall begin after final inspection and acceptance by the project ENGINEER.

END OF SECTION

SUPPLEMENTAL SECTION 04 05 23

MASONRY ACCESSORIES

PART 1: GENERAL

1.0 SUMMARY

- A. Applicable provisions of Division 01 shall govern work of this Section.
- B. Include materials, labor, services and incidentals necessary for completion of this Section of Work.
- C. Extent of unit masonry work is indicated on Drawings.

2.0 REFERENCES AND DEFINITIONS

A. RELATED SECTIONS

- 1. Section 040516 - Mortar And Masonry Grout
- 2. Section 042000 - Unit Masonry
- 3. Section 042235 - Reinforced Block Masonry

B. Industry Standards, Specifications and Codes:

1. General:

- a) Comply with provisions of the following codes and standards except as modified.
- b) Referenced codes and standards including revisions and commentaries shall be the most currently adopted as of the date of these Contract Documents.

2. American Society for Testing and Materials (ASTM):

- a) Specific ASTM numbers are noted in later text.

3. American Concrete Institute (ACI):

- a) ACI 530-05 Building Code Requirement for Masonry Structures
- b) ACI 530.1-05 Specifications for Masonry Structures

4. The Masonry Society

5. International Building Code (IBC) – 2009

- C. Where all or part of a Federal, ASTM, ANSI, AWWA, Arizona Uniform Standard Specification for Public Works Construction etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.

3.0 SUBMITTALS

- A. General: Submit listed submittals in accordance with conditions of the Contract and with Specification 01 33 00.
- A. Product Data: Submit product data, including manufacturer's specifications, installation instructions, and general recommendations for installation. Also include manufacturer's certification or other data substantiating that products comply with requirements of Contract Documents. Clearly identify product/model to be used.
- B. Test Reports: Submit for acceptance, complete test reports from approved independent testing laboratories certifying that product conforms to performance characteristics and testing requirements specified herein.
- C. Shop drawings: Submit clear, concise drawing showing model number, size, arrangement and configuration of all products specified. Minimum sheet size is 8.5" X 11".

4.0 QUALITY ASSURANCE

This section not used.

5.0 STORAGE AND HANDLING

- A. The CONTRACTOR shall be responsible for the safe storage of the equipment until it is incorporated in the completed project.

PART 2: PRODUCTS

1.0 SPECIFICATIONS

A. MASONRY ACCESSORIES

1. Flashing:

- a) Composite Flashing: Flexible membrane, minimum thickness 40 mils, of either adhesive rubberized asphalt bonded to a cross-laminated polyethylene film or EPDM synthetic rubber, with a metal drip edge fully adhered to exterior edge. Metal drip edge to be 27 gage, ASTM A240, Type 304 stainless steel with no. 2D (dull, cold rolled) finish. Fabricate 2 -1/4 inch wide, formed to provide 3/8 inch, 135 degree drip with a 1/4 inch continuous hem. Subject to compliance with requirements including 2-year manufacturer's warranty, provide flashing as a complete system. Select from the following suppliers:

- i. Flexible Flashing:

- 1) Firestone FlashGard by Firestone Building Products.
 - 2) Perm-A-Barrier Wall Flashing by W.R. Grace & Co.
 - 3) Sealtight Air Shield by W.R. Meadows
 - ii. Metal Drip Edge
 - 1) Stainless Steel Drip Edge with prefabricated corners by Illinois Products Corporation or approved equal.
2. Mortar Deflection Device (Cavity Wall Construction):
 - a) Select from the following suppliers:
 - i. Mortar Break by Advanced Building Products Inc. of Springvale, Maine (This product is of recycled material and can offer LEED® advantages)
 - ii. The Mortar Net by Mortar Net USA, Ltd, Gary, Indiana
 - iii. Mortar Net by Sandell Manufacturing Company, Inc.
3. Cell Weeps/Vents:
 - a) Color to be selected by A/E. Select from the following suppliers:
 - i. Cell vent Weep-Hole Ventilator by Dur-O-Wal, Inc.
 - ii. #QV – Quadro-Vent by Hohmann & Barnard, Inc.
 - iii. No. 85 Cell Vent by Heckmann Building Products Inc.
4. Materials:
 - a) Comply with requirements indicated for basic materials and with requirements indicated under each form of horizontal joint reinforcement, tie anchor for size and other characteristic.
 - b) Horizontal joint reinforcement and wire components of adjustable anchor: Provide hot-dip galvanized steel wire complying with ASTM A 82 for uncoated wire and ASTM A 153, Class B-2 (1.5 ounces per square foot of wire surface) for zinc coating applied after prefabrication into units.
5. Sheet metal ties/anchors, dovetail and channel slots, sheet metal components of adjustable ties/anchors and other inserts. Provide hot-dip galvanized carbon steel complying with ASTM A 366, class 2 or ASTM A 635; hot-dip galvanized after fabrication to comply with ASTM A 153, class B.
6. Horizontal Joint Reinforcement:
 - a) Prefabricated electrically flush or butt welded wire units not less than 10 foot long with matching corner and tee units complying with ASTM 951.

- b) Unit width shall be based on nominal wall width as indicated on Drawings providing 1/2 inch mortar cover at interior applications and 5/8 inch mortar cover at exterior applications.

7. Single Wythe Wall Construction:

- a) Running Bond: Units consisting of two 9 gage (0.148 inch diameter) side rods with 9 gage cross rods spaced not over 16 inches o.c. Space units at 16 inches o.c vertically in wall. Select from the following suppliers:
 - i. 2 Wire System Series 300 by Masonry Reinforcing Corporation of America
 - ii. Truss Type DA 3100 by Dur-O-Wal, Inc.
 - iii. #120 Truss-Mesh by Hohmann and Barnard, Inc.
- b) Other Than Running Bond or Stack Bond: CONTRACTOR'S Option: Units consisting of two 9 gage (0.148 inch diameter) side rods with 9 gage cross rods spaced not over 16 inches o.c. Space units at 16 inches o.c. vertically in wall. Select from the following suppliers:
 - i. Units consisting of two 3/16 inch diameter side rods with 9 gage (0.148 inch diameter) cross rods spaced not over 16 inch o.c. Space units at 16 inch o.c. vertically in wall. Select from the following suppliers:
 - 1) 2 Wire System Series 300 by Masonry Reinforcing Corporation of America
 - 2) Truss Type DA 3100 by Dur-O-Wal, Inc.
 - 3) #120 Truss-Mesh by Hohmann and Barnard, Inc.

OR

- ii. Units consisting of two 9 gage (0.148 inch diameter) side rods with 9 gage cross rods spaced not over 16 inch o.c. Space units at 8 inch o.c. vertically in wall. Select from the following suppliers:
 - 1) 2 Wire System Series 300 by Masonry Reinforcing Corporation of America
 - 2) Truss Type D/A 3100 by Dur-O-Wal, Inc.
 - 3) #120 Truss-Mesh by Hohmann and Barnard, Inc.

B. MULTI WYTHE WALL CONSTRUCTION

1. Composite Solid Wall Construction (Interior Brick/CMU and Exterior Brick/CMU):

- a) Running Bond: Units consisting of three 9 gage (0.148 inch diameter) side rods with 9 gage cross rods not over 16 inches o.c. Space units at 16 inches o.c. vertically in wall. Select from the following suppliers:
 - i. 3 Wire System Series 200 by Masonry Reinforcing Corporation of America

- ii. Ladur Type DA 3200 Tri-Rod by Dur-O-Wal, Inc.
- iii. #230 Ladder-Tri-Mesh by Hohmann and Barnard, Inc.

b) Other than Running Bond Or Stack Bond: CONTRACTOR'S Option: Units consisting of three 3/16 inch diameter side rods with 9 gage (0.148 inch diameter) cross rods space not over 16 inches o.c. Space units at 16 inches o.c. vertically in wall. Select from the following suppliers:

- i. 3 Wire System Series 200 by Masonry Reinforcing Corporation of America
- ii. Ladur Type DA 3200 Tri-Rod by Dur-O-Wal, Inc.
- iii. #230 Ladder-Tri-Mesh by Hohmann and Barnard, Inc.

OR

c) Units consisting of two 9 gage (0.148 inch diameter) side rods with 9 gage cross rods spaced not over 16 inches o.c. Space units at 8 inches o.c. vertically in wall. Select from the following suppliers:

- i. 3 Wire System Series 200 by Masonry Reinforcing Corporation of America
- ii. Ladur Type DA 3200 Tri-Rod by Dur-O-Wal, Inc.
- iii. #230 Ladder-Tri-Mesh by Hohmann and Barnard, Inc.

2. Additional Single Tie at Openings:

a) 3/16 inch diameter rods bent to a rectangular shape for hollow units and rods bent to 90 degree angles to provide a 2 inch long hook in other applications. Select from the following suppliers:

- i. DA 510 Rectangular Cavity Wall Tie or DA 500 "Z" Cavity Wall Tie by Dur-O-Wal, Inc.
- ii. No. 253, 2 inch wide Rectangular Wire Tie or No. 251 "Z" Wire Tie by Heckmann Building Products, Inc.

3. Noncomposite Wall Construction (Exterior Brick and Interior CMU):

a) TYPE 2

- i. Running Bond: Units consisting of two 9 gage (0.148 inch diameter) side rods with 9 gage cross rods not over 16 inches o.c. and 2-3/16 inch eye plus matching 3/16 inch, 2-leg pintle spaced at 16 inches o.c. Maximum clearance between connecting eye-pintle assembly shall be 1/16 inch. Pintle horizontal leg size shall be selected based on cavity dimension and reinforcement clear cover requirements indicated in this Specification. Space units at 16 inches o.c. vertically in wall. Select from the following suppliers:

- 1) Series 900 by Masonry Reinforcing Corporation of America
 - 2) Dur-O-Eye Type D/A 3700 by Dur-O-Wal, Inc.
 - 3) Lox All Adjustable Eye-Wire Truss Type #170 by Hohmann and Barnard, Inc.
- ii. Other Than Running Bond Or Stack Bond: CONTRACTOR'S Option: Units consisting of two 3/16 inch diameter side rods with 9 gage (0.148 inch diameter) cross rods space not over 16 inches o.c. and 2-3/16 inch eye plus matching 3/16 inch, 2-leg pintle spaced at 16 inches o.c. Maximum clearance between connecting eye-pintle assembly shall be 1/16 inch. Pintle horizontal leg size shall be selected based on cavity dimension and reinforcement clear cover requirements indicated in this Specification. Space units at 16 inches o.c. vertically in wall. Select from the following suppliers:

- 1) Series 900 by Masonry Reinforcing Corporation of America
- 2) Dur-O-Eye Type DA 3700 by Dur-O-Wal, Inc.
- 3) Lox All Adjustable Eye-Wire Truss Type #170 by Hohmann and Barnard, Inc.

OR

- iii. Units consisting of two 9 gage (0.148 inch diameter) side rods with 9 gage cross rods spaced not over 16 inches o.c. and 2-3/16 inch eye plus matching 3/16 inch, 2-leg pintle spaced at 16 inches o.c. Maximum clearance between connecting eye-pintle assembly shall be 1/16 inch. Pintle horizontal leg size shall be selected based on cavity dimension and reinforcement clear cover requirements indicated in this specification. Space units at 8 inches o.c. vertically in wall. Select from the following suppliers:

- 1) Series 900 by Masonry Reinforcing Corporation of America
- 2) Dur-O-Eye Type DA 3700 by Dur-O-Wal, Inc.
- 3) Lox All Adjustable Eye-Wire Truss Type #170 by Hohmann and Barnard, Inc.

- iv. Anchorage to Structural Steel. Select from the following products (or approved equal):

- 1) DA 901 Channel Anchor Slot plus DA 918 3/16" wire Channel Anchor by Dur-O-Wal, Inc.
- 2) #360 Gripstay Channel plus #363 3/16" wire Gripstay Anchor by Hohmann and Barnard, Inc.
- 3) No. 130 Weld-On Channel Slot plus No. 129 1/8" anchor with 3/16" triangle wire tie Anchor by Heckmann Building Products, Inc.
- 4) No. 75 Pos-I-Tie Self Drilling Screws plus Galvanized Triangle Wire Tie by Heckmann Building Products, Inc.

- v. Anchorage to Cold-Formed metal framing. Select from the following products (or approved equal):
 - 1) 14 Ga. RJ-711 Adjustable Veneer Anchor with 3/16" diameter pintles by Masonry Reinforcing Corporation of America
 - 2) 14 Ga. HB-200 Adjustable Veneer Anchor with 3/16" diameter pintles by Hohmann and Barnard, Inc.
 - 3) 14 Ga. #213 Wire Veneer Anchor System with 3/16" diameter pintles by Heckmann Building Products, Inc.

4. Adhered Veneer Wall Construction (Exterior Brick and Interior CMU):

a) TYPE 4

- i. Running Bond: Units consisting of two 9 gage (0.148 inch diameter) side rods with 9 gage cross rods not over 16 inches o.c. and 2-3/16 inch eye plus matching 3/16 inch, 2-leg pintle spaced at 16 inches o.c. Maximum clearance between connecting eye-pintle assembly shall be 1/16". Pintle horizontal leg size shall be selected based on cavity dimension and reinforcement clear cover requirements indicated in this Specification. Space units at 16 inches o.c. vertically in wall. Select from the following suppliers:
 - 1) Series 900 by Masonry Reinforcing Corporation of America
 - 2) Dur-O-Eye Type DA 3700 by Dur-O-Wal, Inc.
 - 3) Lox All Adjustable Eye-Wire Truss Type #170 by Hohmann and Barnard, Inc.
- ii. Other Than Running Bond Or Stack Bond: CONTRACTOR'S Option: Units consisting of two 3/16 inch diameter side rods with 9 gage (0.148 inch diameter) cross rods space not over 16 inches o.c. and 2-3/16 inch eye plus matching 3/16 inch, 2-leg pintle spaced at 16 inches o.c. Maximum clearance between connecting eye-pintle assembly shall be 1/16 inch. Pintle horizontal leg size shall be selected based on cavity dimension and reinforcement clear cover requirements indicated in this specification. Space units at 16 inches o.c. vertically in wall. Select from the following suppliers:
 - 1) Series 900 by Masonry Reinforcing Corporation of America
 - 2) Dur-O-Eye Type DA 3700 by Dur-O-Wal, Inc.
 - 3) Lox All Adjustable Eye-Wire Truss Type #170 by Hohmann and Barnard, Inc.

OR

iii. Units consisting of two 9 gage (0.148 inch diameter) side rods with 9 gage cross rods spaced not over 16 inches o.c. and 2-3/16 inch eye plus matching 3/16 inch, 2-leg pintle spaced at 16 inches o.c. Maximum clearance between connecting eye-pintle assembly shall be 1/16 inch. Pintle horizontal leg size shall be selected based on cavity dimension and reinforcement clear cover requirements indicated in this specification. Space units at 8 inches o.c. vertically in wall. Select from the following suppliers:

- 1) Series 900 by Masonry Reinforcing Corporation of America
- 2) Dur-O-Eye Type DA 3700 by Dur-O-Wal, Inc.
- 3) Lox All Adjustable Eye-Wire Truss Type #170 by Hohmann and Barnard, Inc.

C. ADHERED VENEER WALL CONSTRUCTION WITH INDIVIDUAL ANCHORS (EXTERIOR BRICK AND INTERIOR CMU)

1. See Single Wythe Wall Construction for CMU backup wall horizontal joint reinforcement requirements.

2. Anchors

a) Corrugated Sheet Metal Anchors: Units shall be 7/8 inch wide and have a base metal thickness of 0.03 inch with corrugations with a wavelength of 0.3 inch to 0.5 inch and amplitude of 0.06 inch to 0.10 inch. Select from the following suppliers:

- i. Corrugated Wall Ties Series 2000 by Masonry Reinforcing Corporation of America
- ii. DA 990 Corrugated Wall Ties by Dur-O-Wal, Inc.
- iii. CWT-Corrugated Wall Ties by Hohmann and Barnard, Inc.

b) Sheet Metal Anchors: Units shall be 7/8 inch wide and have a base metal thickness of 0.06 inch. Anchors shall have corrugations with a wavelength of 0.3 inch to 0.5 inch and amplitude of 0.06 inch to 0.10 inch or be bent, notched or punched to provide an equivalent performance in pull-out or push-through. Select from the following suppliers:

- i. Corrugated Wall Ties Series 2000 by Masonry Reinforcing Corporation of America
- ii. DA 990 Corrugated Wall Ties by Dur-O-Wal, Inc.
- iii. CWT-Corrugated Wall Ties by Hohmann and Barnard, Inc.

c) Wire Anchors: Units shall be at least 9 gage (0.148 inch diameter) wire and have ends bent to form an extension from the bend at least 2 inches long. Select from the following suppliers:

- i. DA 500 "Z" Cavity Wall Tie by Dur-O-Wal, Inc.
- ii. #351 – Wire Column Tie by Hohmann and Barnard, Inc.

iii. "Z" Wire Tie No. 251 by Heckmann Building Products, Inc.

d) Post Installed Adjustable Anchors: Adjustable Corrugated Sheet Metal Anchors shall be 7/8 inch wide and have a base metal thickness of 0.03 inch with corrugations with a wavelength of 0.3 inch to 0.5 inch and amplitude of 0.06 inch to 0.10 inch. Adjustable Sheet Metal Anchors shall be 7/8 inch wide and have a base metal thickness of 0.06 inch. Anchors shall have corrugations with a wavelength of 0.3 inch to 0.5 inch and amplitude of 0.06 inch to 0.10 inch or be bent, notched or punched to provide an equivalent performance in pull-out or push-through. Adjustable Pintle Anchors shall have 2-leg pintle spaced at 16 inches o.c. Horizontal leg size of adjustable assemblies shall be selected based on cavity dimension and reinforcement clear cover requirements indicated in this specification. Maximum clearance between connecting parts of adjustable anchor assemblies shall be 1/16 inch. Adjustable assemblies shall be fabricated to prevent disengagement between individual components. Select an assembly meeting requirements noted above or from the following suppliers:

- i. RJ-711 Adjustable Veneer Anchor by Masonry Reinforcing Corporation of America
- ii. DA 5213 by Dur-O-Wal, Inc.
- iii. No. 213 Wire Veneer Anchor System by Heckmann Building Products, Inc.

D. ADHERED VENEER WALL CONSTRUCTION WITH INDIVIDUAL ANCHORS (EXTERIOR BRICK AND INTERIOR WOOD STUDS)

1. Corrugated Sheet Metal Anchors shall be 7/8 inch wide and have a base metal thickness of 0.03 inch with corrugations with a wavelength of 0.3 inch to 0.5 inch and amplitude of 0.06 inch to 0.10 inch. Sheet Metal Anchors shall be 7/8 inch wide and have a base metal thickness of 0.06 inch. Anchors shall have corrugations with a wavelength of 0.3 inch to 0.5 inch and amplitude of 0.06 inch to 0.10 inch or be bent, notched or punched to provide an equivalent performance in pull-out or push-through. Corrugated Anchors may only be used when the distance between the inside face of veneer and outside face of solid sheathing is 1 inch or less. Pintle Anchors shall have 2-leg pintle spaced at 16 inches o.c. Horizontal leg size of adjustable assemblies shall be selected based on cavity dimension and reinforcement clear cover requirements indicated in this specification. Maximum clearance between connecting parts of adjustable anchor assemblies shall be 1/16 inch. Adjustable assemblies shall be fabricated to prevent disengagement between individual components. Select an assembly meeting requirements noted above or from the following suppliers:

- a) RJ-711 Adjustable Veneer Anchor by Masonry Reinforcing Corporation of America
- b) DA 5213 by Dur-O-Wal, Inc.
- c) No. 213 Wire Veneer Anchor System by Heckmann Building Products, Inc.

E. ADHERED VENEER WALL CONSTRUCTION WITH INDIVIDUAL ANCHORS (EXTERIOR BRICK AND INTERIOR STEEL STUDS)

1. See section 054000 Cold-Formed Steel Framing for steel stud criteria reinforcement requirements.
2. Adjustable pintle anchors shall have 2-leg pintle spaced at 16 inches o.c. Horizontal leg size of adjustable assemblies shall be selected based on cavity dimension and reinforcement clear cover requirements indicated in this Specification. Maximum clearance between connecting parts of adjustable anchor assemblies shall be 1/16 inch. Adjustable assemblies shall be fabricated to prevent disengagement between individual components. Select an assembly meeting requirements noted above or from the following suppliers:
 - a) RJ-711 Adjustable Veneer Anchor by Masonry Reinforcing Corporation of America
 - b) DA 213 Veneer Anchoring Systems by Dur-O-Wal, Inc.
 - c) No. 213 Wire Veneer Anchor System by Heckmann Building Products, Inc.
3. Anchorage to Structural Steel:
 - a) Select from the following suppliers (or equal):
 - i. DA 901 Channel Anchor Slot plus DA 918 3/16" wire Channel Anchor by Dur-O-Wal, Inc.
 - ii. #360 Gripstay Channel plus #363 3/16" wire Gripstay Anchor by Hohmann and Barnard, Inc.
 - iii. No. 130 Weld-On Channel Slot plus No. 129 1/8" anchor with 3/16" triangle wire tie Anchor by Heckmann Building Products, Inc.
 - iv. No. 75 Pos-I-Tie Self Drilling Screws plus Galvanized Triangle Wire Tie by Heckmann Building Products, Inc.
4. Anchorage to Poured-In-Place Concrete:
 - a) CONTRACTORS performing work in Divisions 03 and 04 shall coordinate to verify who is supplying and installing components. Component incompatibility is CONTRACTORS' responsibility. Brick anchor length shall be selected based on cavity dimension and reinforcement clear cover requirements indicated in this Specification. Select from the following suppliers:
 - b) DA 100 24 gage Dovetail Slot with foam filler plus DA 720 3/16" wire Dovetail Brick Anchor by Dur-O-Wal, Inc.
 - c) #305 22 gage Dovetail Slot with foam filler plus #315 flexible wire Dovetail Brick Tie by Hohmann and Barnard, Inc.
 - d) No. 100 24 gage Standard Dovetail Slot with foam filler plus No. 103 12 gage Dovetail anchor with #316 triangle wire Tie by Heckmann Building Products, Inc.
5. Preformed Control Joint Gaskets:

- a) Provide preformed styrene-butadiene rubber conforming to ASTM D2000m designation 2 AA-805. Select from the following suppliers:
 - i. DA 2001 by Dur-O-Wal, Inc.
 - ii. 2002 by Masonry Reinforcing Corporation of America
 - iii. RS-6 by Hohmann and Barnard, Inc.

6. Joint Stabilization Anchors:

- a) DA 2200 Joint Stabilization Anchor by Dur-O-Wal, Inc.
- b) Series 1700 Control Joint Anchor by Masonry Reinforcing Corporation of America
- c) "Slip-Set" Stabilizer by Hohmann and Barnard, Inc.

7. Partition Top Stabilization Anchors:

- a) Select from the following suppliers:
 - i. Masonry Wall-Top DA 411 Stabilization Anchor by Dur-O-Wal, Inc.
 - ii. #PTA-420 Partition Top Anchor plus #NS closure by Hohmann and Barnard, Inc.
 - iii. No. 419 Masonry Wall Stabilization Anchor plus No. 421 Plastic Tube by Heckmann Building Products, Inc.
 - iv. No. 4300 Partition Top Anchor plus No. 4305 Plastic Tube by Masonry Reinforcing Corporation of America

8. Reinforcing Bar Positioners: (THE USE OF POSITIONERS FOR REINFORCEMENT IN REINFORCED MASONRY IS STRONGLY RECOMMENDED)

- a) Dur-O-Wal, Inc. – any DA 800 Series positioner as required for orientation/use

9. Screws for Attachment of Anchors to Steel Stud/Steel Backup:

- a) Steel, having a nominal shank diameter of not less than 0.190 (not including finishes) by length required to penetrate steel stud/steel backup flange by not less than 3 exposed threads, complying with ASTM C 954 except with hex washer head and neoprene washer with organic polymer coating with salt spray resistance to red rust of more than 800 hours per ASTM B 117.

10. Compressible Filler:

- a) Pre-molded filler strips complying with ASTM D 1056, class RE41 and 2A1 for closed cell neoprene compressible up to 35 percent. Provide and install width and thickness as indicated or detailed on Drawings.

11. Building Paper:

- a) Asphalt-saturated organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt.). Provide and install as indicated or detailed on Drawings.

2.0 MATERIALS

This section not used.

3.0 PRE-APPROVED MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work, include, but are not limited to, the following:
 - 1. As noted throughout this section.
- B. Substitutions /or Equal: If alternative manufacturers other than the pre-approved manufacturer are proposed for any specified equipment in this section, the CONTRACTOR/bidder must supply a submittal, refer to STS 01 33 00.
- C. Although the brands listed herein are the preferred brands, it is not the intent of the OWNER for these specifications to be proprietary; equals will be evaluated in accordance with comparable quality, construction, strength, durability, and suitability for the purpose intended and are listed for the purpose of describing the standard of quality performance and characteristics.
- D. Manufacturers listed in this specification do not constitute approval. All equipment must have the capabilities and functions as specified herein.

PART 3: EXECUTION

1.0 CONTRACTOR'S RESPONSIBILITY

- A. The CONTRACTOR is responsible for furnishing and installing the PRODUCT including all site preparation, and other items necessary for the proper installation and operation of the PRODUCT.

2.0 EXAMINATION

- A. Examine all products for compliance with this section.
- B. Proceed with installation only after unsatisfactory conditions have been corrected

3.0 PREPARATION

This section not used.

4.0 INSTALLATION

A. FLASHING

1. Install concealed flashing and cell vents to comply with manufacturer's recommendations and installation instructions in masonry at shelf angles, lintels, sills, ledges and other obstructions to downward flow of water in wall to divert water to exterior.
 - a) Wall surfaces to be clean and free of dirt, dust, protrusions, and foreign materials that could puncture flashing. Wall surface must be dry prior to installation of flashing system.
 - b) Unless otherwise indicated, install through-wall flashing so that a constant positive or zero slope is maintained from inside of wall to exterior surface. Pocketed and back sloped flashing will be rejected and replaced.
 - c) Locate flashing at same horizontal joint as weight support of masonry not in other joints above or below so that only 1 weakened plane of bond is created.
 - d) Install exterior drip edge tight to exterior face of masonry. Form corners with no exposed sharp edges or projections.
2. Flashing material is not to be exposed to direct sunlight for longer than 30 days.
3. Provide end dams at horizontal termination points.
4. Lap end joints minimum 4 inch and seal watertight using flashing manufacturer's recommended adhesive.
5. Stainless steel drip edge shall be held in place during construction with a continuous bead of urethane sealant or equivalent. Bent hemmed edge portion of stainless steel drip edge must extend beyond vertical face of masonry wall.
6. At multi-wythe masonry walls, extend flashing from exterior face of outer wythe of masonry, through outer wythe, turned up a minimum of 4 inch and through inner wythe to within 1/2 inch of interior face of wall in exposed masonry. Where interior surface of inner wythe is concealed, carry flashing completely through inner wythe and turn flashing up approximately 2 inch unless indicated otherwise.
7. At masonry veneer walls with steel or wood stud backup, extend flashing from exterior face of veneer, through veneer, up face of sheathing not less than 8 inch and behind air-infiltration barrier.
8. Flexible flashing shall be lapped over and fully adhered to metal drip. Edge of flexible flashing shall be set back not less than 1/2 inch from exposed exterior surface.
9. At Lintels, sills and shelf angles, extend flashing a minimum of 4 inches into masonry at each end. At ends of flashing and heads and sill, columns abutments and movement joints, turn flashing up not less than 2 inches to form end dams. Do not expose end dams.

10. Cell Weeps/Vents:

- a) Install cell weeps/vents per manufacturer's recommendations.
- b) Cell weeps shall be placed at flashing locations. Place cell weeps in vertical (head) joint of exterior masonry wythe of first course of masonry immediately above embedded flashing and set back 1/8 inch from exterior face of wythe spaced at 24 inches oc.
- c) Cell vents shall be placed at top of obstructed cavities such as top of wall or relief angle locations. Place cell vents in vertical (head) joint of exterior masonry wythe of first course of masonry immediately below cavity obstruction and set back 1/8 inch from exterior face of wythe spaced at 24 inches oc.
- d) Place openings/corrugations horizontal to allow water to flow from cavity to exterior.

11. Mortar Deflection Device (Cavity Wall Construction):

- a) Install mortar net in collar joint or cavity per manufacturer's recommendation. Place mortar net directly over flashing. At insulated cavity wall construction, place mortar net between inside face of exterior wythe of masonry and exterior face of insulation.

12. Horizontal Joint Reinforcement:

- a) Wall joint reinforcement shall be discontinuous at expansion and control joint locations.
- b) Ties and anchors in multi-wythe wall construction (except composite walls) may not be bent after installation such that corrosive resistant finish is not damaged. Ties and anchors that are bent such that corrosive resistant finish is damaged shall be replaced. Post Installed Adjustable Anchor or corrosive resistant finish will be repaired.
- c) In multi-wythe composite wall construction, install joint reinforcing as indicated in product section. Collar joint shall be grouted (not mortared) solid.
- d) In multi-wythe wall construction with adjustable ties or anchors, bed joint misalignment shall not exceed 1 1/4 inch.
- e) Place joint reinforcement in first and second horizontal joints above and below openings. Extend 16 inches minimum each side of opening.
- f) Place joint reinforcement continuous in first and second joint below top of walls.

- g) Lap joint reinforcement ends minimum 6 inches.
- h) Place joint reinforcement so that longitudinal wires are embedded in mortar with a minimum cover of 1/2 inch when not exposed to weather or earth and 5/8 inch when exposed to weather or earth.

13. Wall Ties at Openings:

- a) Embed the ends of wall ties in mortar joints. Embed wall tie ends at least 1/2 inches into outer face shell of hollow units. Embed wire wall ties at least 1 1/2 inches into mortar bed of solid masonry units or solid grouted hollow units.
- b) Unless otherwise required, provide additional unit ties around openings larger than 16 inches in either direction. Space ties around perimeter of opening at a maximum of 3'-0" on center. Place ties within 12 inches of opening.

14. Veneer Anchors

- a) Corrugated Sheet Metal Anchors: Embed anchors in mortar joints for solid masonry units or in mortar or grout for hollow masonry units. Extend anchors into veneer not less than 1 1/2 inches with at least 5/8 inch mortar or grout cover to outside face.
- b) Sheet Metal Anchors: Embed anchors in mortar joints for solid masonry units or in mortar or grout for hollow masonry units. Extend anchors into veneer not less than 1 1/2 inches with at least 5/8 inch mortar or grout cover to outside face.
- c) Wire Anchors: Embed anchors in mortar joints for solid masonry units or in mortar or grout for hollow masonry units. Extend anchors into veneer not less than 1 1/2 inches with at least 5/8 inch mortar or grout cover to outside face.
- d) Anchor Spacing: Space adjustable two-piece 9 gage (0.148 inch diameter) wire and 22 gage corrugated sheet metal anchors at maximum 16 inch o.c. vertically and 24 inch o.c. horizontally.
- e) Space other anchors at maximum 16 inches on center vertically and 31 inches on center horizontally.
- f) Provide not less than 1 additional anchor on each edge of openings greater than 16 inches in either direction, but spaced less than 36 inches o.c. Place anchor within 12 inches of openings.

B. ADHERED VENEER WALL CONSTRUCTION WITH INDIVIDUAL ANCHORS (EXTERIOR BRICK AND INTERIOR WOOD STUDS)

1. Attach each anchor to wood studs or wood framing per manufacturer's recommendations, but with not less than 1 corrosion-resistant 8d common nail or fastener with equivalent or greater pull out strength.
2. Locate nail or fastener within 1/2 inches of 90 degree bend in anchor for corrugated sheet metal anchors.
3. Extend anchors into veneer not less than 1 1/2 inches with at least 5/8 inch mortar or grout cover to outside face.
4. Space adjustable 2-piece 9 gage (0.148 inch diameter) wire and 22 gage corrugated sheet metal anchors at maximum 16 inches o.c. vertically and 24 inches o.c. horizontally.
5. Space other anchors at maximum 16 inches on center vertically and 31 inches on center horizontally.
6. Provide not less than 1 additional anchor on each edge of openings greater than 16 inches in either direction, but spaced less than 36 inches o.c. Place anchor within 12 inches of openings.

C. ADHERED VENEER WALL CONSTRUCTION WITH INDIVIDUAL ANCHORS (EXTERIOR BRICK AND INTERIOR STEEL STUDS)

1. Attach each anchor directly to steel studs (not over sheathing material) per manufacturer's recommendations using corrosion-resistant screws with a nominal shank diameter of not less than 0.190 inches unless manufacturer requires a larger minimum screw size.
2. Extend anchors into veneer not less than 1 1/2 inches with at least 5/8 inch mortar or grout cover to outside face.
3. Space adjustable 2-piece 9 gage (0.148 inch diameter) wire and 22 gage corrugated sheet metal anchors at maximum 16 inches o.c. vertically and 24 inches o.c. horizontally.
4. Space other anchors at maximum 16 inches on center vertically and 31 inches on center horizontally.
5. Provide not less than 1 additional anchor on each edge of openings greater than 16 inches in either direction, but spaced less than 36 inches o.c. Place anchor within 12 inches of openings.
6. Anchors to Structural Steel:
 - a) Shop weld channels slot with channel vertical to beam webs spaced at 24 inches oc longitudinally on each face of beam that masonry is attached. For beams greater than 21 inch deep, provide additional rows of channel slots spaced at 16 inches oc vertically. Stagger rows. Channel slots shall be located on web so that the center of the channels slot occurs at masonry coursing.

- b) Shop weld channels slot with channel vertical to each column surface that a masonry wall abuts spaced at 16 inches oc vertically.
- c) One anchor shall be placed in each slot. Extend anchors into the veneer not less than 1 ½ inch with at least 5/8 inch mortar or grout cover to the outside face.

7. Anchorage To Poured-In-Place Concrete:

- a) Dovetail slots with foam are to be cast in concrete with the slot vertical at 24 inches o.c. laterally unless detailed otherwise.
- b) Nail slots filler side toward form at 12 inches o.c.
- c) Foam and debris shall be removed from slot so that anchors can slide unobstructed in slot.
- d) Anchors shall be placed in slot at 16 inches o.c. vertically. Extend anchors into veneer not less than 1 1/2 inches with at least 5/8 inch mortar or grout cover to outside face.
- e) Insert anchor into slot and turn 90 degrees to lock into slot.

8. Control Joints - Preformed Control Joint Gaskets:

- a) Wall joint reinforcement shall be discontinuous at control joint locations.
- b) Gasket designed to fit in standard sash block. Install gasket per manufacturer's recommendations.

9. Joint Stabilization Anchors:

- a) Joint stabilization anchor shall be spaced at 16 inches o.c. vertically at expansion joints in masonry wall.
- b) Flange of anchor shall be placed set in mortar for solid units and grout or mortar for hollow units.

10. Partition Top Stabilization Anchors:

- a) Space anchors at 16 inches o.c with long dimension of attachment plate perpendicular to wall.
- b) Attach anchors to underside of masonry, concrete (except post-tensioned) or concrete slab on metal deck with expansion anchors per manufacturer's recommendations. Maintain same clearance between bottom of bolt head (and projecting bolt) and as indicated between top of wall and bottom of structure.

- c) Attach anchors to underside of steel beams via fillet weld per manufacturer's recommendations.
- d) With plastic tube sleeve covering dowel, mortar assembly into core of block.

5.0 WARRANTY

The PRODUCT and work shall be warranted against defects in material and workmanship for a period of one year. The warranty period shall begin after final inspection and acceptance by the project ENGINEER.

END OF SECTION

SUPPLEMENTAL SECTION 04 20 00

UNIT MASONRY

PART 1: GENERAL

1.0 SUMMARY

- A. Applicable provisions of Division 01 shall govern work of this Section.
- B. Include materials, labor, services and incidentals necessary for completion of this Section of Work.
- C. Extent of unit masonry work is indicated on Drawings.
- D. Products installed, but not furnished, under this section include the following:
 - 1. Steel lintels and shelf angles for unit masonry, furnished under Division 05 Section "Metal Fabrications".

2.0 REFERENCES AND DEFINITIONS

A. RELATED SECTIONS:

- 1. Section 040516 – MORTAR
- 2. Section 040523 - MASONRY ACCESSORIES
- 3. Section 042235 - REINFORCED UNIT MASONRY

B. REFERENCES

- 1. Industry Standards, Specifications and Codes:
 - a) General:
 - i. Comply with provisions of the following codes and standards except as modified herein.
 - ii. Referenced codes and standards, including revisions and commentaries shall be the most currently adopted as of the date of these Contract Documents.
 - b) National Concrete Masonry Association (NCMA)
 - c) The Brick Institute Of America (BIA)
 - d) American Society For Testing And Materials (ASTM):

- i. Specific ASTM numbers are noted in later text
 - e) American Concrete Institute (ACI):
 - i. ACI 530-05 Building Code Requirement for Masonry Structures
 - ii. ACI 530.1-05 Specifications for Masonry Structures
 - f) The Masonry Society
 - g) International Building Code (IBC) – 2009
- C. Where all or part of a Federal, ASTM, ANSI, AWWA, and Arizona Uniform Standard Specification for Public Works Construction etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.

3.0 SUBMITTALS

- A. General: Submit listed submittals in accordance with conditions of the Contract and with Specification 01 33 00.
- A. Product Data: Submit product data, including manufacturer's specifications, installation instructions, and general recommendations for installation. Also include manufacturer's certification or other data substantiating that products comply with requirements of Contract Documents. Clearly identify product/model to be used.
- B. Test Reports: Submit for acceptance, complete test reports from approved independent testing laboratories certifying that product conforms to performance characteristics and testing requirements specified herein.
- C. Shop drawings: Submit clear, concise drawing showing model number, size, arrangement and configuration of all products specified. Minimum sheet size is 8.5" X 11".

4.0 QUALITY ASSURANCE

- A. Compressive strength may be determined by either unit strength method or prism test method as identified in Chapter 21 of the IBC 2006. Unit strength method may be used if requirements of these Specifications are followed.
- B. Tolerances:
 - 1. Variation from Unit to Adjacent Unit: 1/32 inch maximum.
 - 2. True to a Line: plus 1/4 inch in 10 feet, plus 3/8 inch in 20 feet, plus 1/2 inch maximum.
 - 3. Variation from Plumb: 1/4 inch in 10 feet, 3/8 inch in 20 feet, 1/2 inch maximum.

4. Variation from Level: Bed Joints: plus 1/4 inch in 10 feet, plus 1/2 inch maximum.
5. Top Surface of Bearing Walls: plus 1/4 inch in 10 feet, 1/2 inch maximum.
6. Mortar Joint Thickness:
 - a) Bed Joint: plus/minus 1/8 inch
 - b) Head: minus 1/4 inch plus 3/8 inch
 - c) Collar: minus 1/4 inch plus 3/8 inch
 - d) In Cross-Section or Elevation: minus 1/4 inch, plus 1/2 inch.
 - e) Grout Space or Cavity Width: minus 1/4 inch, plus 3/8 inch.
 - f) Alignment of Columns and Walls (bottom versus top): plus 1/2 inch for bearing walls, plus 3/4 inch for nonbearing walls.
 - g) Indicated in Plan: plus 1/2 inch in 20 feet, plus 3/4 inch maximum.
 - h) Indicated in Elevation: plus 1/4 inch in story height, plus 3/4 inch maximum.
 - i) For multiple Wythe walls anchored together with wall ties, the maximum misalignment of bed joints from one Wythe to the other is 1 1/4 inch.
7. Mock-Up:
 - a) Provide mock-up panel for approval prior to proceeding with Work.
 - b) Remove panel when directed by A/E. Approved panel may be incorporated into Work at discretion of A/E.

- C. Clean completed Work as Work progresses to avoid excessive final cleaning.
- D. Maintain protective boards at exposed external corners which may be damaged by construction activities.
- E. Provide protection without damaging completed Work.
- F. At day's end cover unfinished walls to prevent moisture infiltration.

5.0 STORAGE AND HANDLING

- A. The CONTRACTOR shall be responsible for the safe storage of the equipment until it is incorporated in the completed project.

- B. Carefully pallet or neatly stack brick and block on site undamaged and adequately protected. Upon delivery of brick and block to Job Site, compare with approved sample and report deviations immediately to OWNER. Conform to requirements specified. Cull-out, credit and immediately remove defective brick from Site. Re-sort or cull as necessary, especially when plant palletted, to avoid spotty or irregular ranges of color or texture in finished wall.

PART 2: PRODUCTS

1.0 SPECIFICATIONS

A. COURSING

1. Place masonry to lines and levels indicated on Drawings.
2. Maintain masonry courses to uniform width. Make vertical and horizontal joints equal and of uniform thickness.
3. Lay concrete masonry units in running bond. Course 1 block unit and 1 mortar joint to equal 8 inch. Form concave mortar joints in exposed to view surfaces and flush elsewhere.

B. PLACING AND BONDING

1. Use standard size face brick throughout.
2. Construct face brick piers between windows using both standard and modular units as required to maintain uniform joints.
3. Construct soldier courses and arches with modular size face brick.
4. Patch, in-fill and tooth at existing building using colored mortar to match existing mortar as closely as possible. A/E to approve dried mortar samples prior to construction of in-fill work.
5. Head joints shall be fully mortared.
6. Hollow units shall be placed such that face shells of bed joints are fully mortared.
7. Webs and face shells shall be fully mortared in piers, columns, pilasters in starting course of wall and where adjacent cores are to be grouted solid.
8. Solid units shall be placed in a fully mortared bed and head joint. Ends of units shall be fully buttered. Head joints shall not be filled by slushing with mortar. Head joints shall be constructed by shoving mortar tight against adjoining unit. Bed joints shall not be furrowed enough to produce voids.
9. Open-end units with beveled ends shall be fully grouted.

10. Provide solid masonry (or bond beam as detailed on Drawings) at course prior to transition from single Wythe to multiple Wythe wall, change in wall thickness or a corbel.
11. Fully bond intersections and external and internal corners.
12. Units shall be placed while mortar is soft and plastic. Units disturbed to the extent the initial bond is broken after positioning shall be removed and relaid in fresh mortar.
13. Remove excess mortar.
14. Perform jobsite cutting with proper tools to provide straight, clean and non-chipped edges. Take care to prevent breaking masonry unit corners or edges. Use no masonry with broken or chipped exposed surfaces.
15. Cut mortar joints of masonry units flush where resilient base is scheduled or cavity insulation vapor barrier adhesive is applied.
16. Isolate masonry partitions from vertical structural framing members with a slip joint as indicated on Drawings.
17. Top course of walls or joist bearing point, unless otherwise noted, shall be a bond beam filled with grout with two #5 reinforcing bars continuous.
18. Pilasters noted shall be filled solid with grout and include four #6 reinforcing bars minimum vertical unless noted otherwise on Drawings.

C. CAVITY WALL

1. Install mortar net as recommend by manufacturer.
2. Do not let mortar fall into cavity air space, control joint voids or plug weep holes; clean out promptly.
3. Install weep ventilators in veneer at 24 inch on center horizontally above through-wall flashing, above shelf angles and at bottom of walls and as recommended by manufacturer.
4. Install vapor retarder and air barrier as indicated on Drawings and in Specifications
5. Fill concrete block units with insulation when indicated on Drawings.
6. Build inner Wythe ahead of outer Wythe to receive cavity insulation. Obtain insulation from Section 072113 CONTRACTOR and install as work progresses. Spot adhere to substrate to hold in place.
7. Install building paper over insulation or sheathing as indicated on Drawings and in Specifications.

8. Ends of wall ties shall be embedded in mortar joints. Wall tie ends shall be engaged outer face shell of hollow units by at least 1/2 inch. Wire wall ties shall be embedded at least 1 1/2 inch into mortar bed of solid masonry or solid grouted hollow units.

D. COLD WEATHER CONSTRUCTION

1. Implement the following when:

- a) Ambient temperature falls below 40 degrees F
- b) Ambient temperature of masonry units is below 40 degrees F.

2. In Addition:

- a) Do not lay masonry units having a temperature below 20 degrees F. Remove visible ice on masonry units before unit is laid in masonry.
- b) Heat mortar and mixing water to produce mortar temperatures between 40 degrees F and 120 degrees F at time of mixing. Maintain mortar above freezing until used in masonry.
- c) When ambient temperature is between 25 degrees F and 20 degrees F, use heat source on both sides of masonry under construction and install wind breaks when wind velocity is in excess of 15 miles per hour (mph).
- d) When ambient temperature is below 20 degrees F, provide an enclosure for masonry under construction and use heat source to maintain temperature above 32 degrees F within enclosure.
- e) When daily mean temperature is between 40 degrees F and 32 degrees F, protect completed masonry from rain or snow by covering with a weather resistive membrane for 24 hours after construction.
- f) When daily mean temperature is between 32 degrees F and 25 degrees F, completely cover completed masonry with a weather resistive membrane for 24 hours after construction.
- g) When daily mean temperature is between 25 degrees F and 20 degrees F, completely cover completed masonry with insulated blankets or equal; protect for 24 hours after construction.
- h) When daily mean temperature is below 20 degrees F, maintain masonry temperature above 32 degrees F for 24 hours after construction by enclosure with supplementary heat, by electric heating blankets, by infrared heat lamps or by other acceptable methods.

- i) Do not lay glass block unit masonry during cold weather construction periods as defined in Article 1.8c.1a or 1.8c.1b of ACI 530.1-05. Maintain temperature of glass unit masonry above 40 degrees F for first 48 hours after construction.

E. HOT WEATHER CONSTRUCTION

1. Implement approved hot weather procedures and comply with the following provisions:

a) Preparation – Prior to conducting masonry work:

- i. When ambient air temperature exceeds 100 degrees F, or exceeds 90 degrees F with a wind velocity greater than 8 mph:
 - 1) Maintain sand piles in a damp, loose condition.
 - 2) Provide necessary conditions and equipment to produce mortar having a temperature below 120 degrees F.
- ii. When ambient temperature exceeds 115 degrees F with a wind velocity greater than 8 mph, implement requirements of Article 1.8 D.1 of ACI 530.1-05 and shade material and mixing equipment from direct sunlight.

b) Construction – While masonry work is in progress:

- i. When ambient air temperature exceeds 100 degrees F, or exceeds 90 degrees F with a wind velocity greater than 8 mph:
 - 1) Maintain temperature of mortar and grout below 120 degrees F.
 - 2) Flush mixer, mortar transport container and mortar boards with cold water before they come in contact with mortar ingredients or mortar.
 - 3) Maintain mortar consistency by retempering with cool water.
 - 4) Use mortar within 2 hours of mixing.
- ii. When ambient air temperature exceeds 115 degrees F, or exceeds 105 degrees F with a wind velocity greater than 8 mph, implement requirements of Article 1.8.D.2a and use cool mixing water for mortar and grout. Ice is permitted in mixing water prior to use. Do not permit ice in mixing water when added to other mortar or grout materials.
- iii. Protection – When mean daily temperature exceeds 100 degrees F or exceeds 90 degrees F with a wind velocity of 8 mph, fog newly constructed masonry until damp, at least 3 times a day until masonry is 3 days old.

F. LINTELS

1. Install loose steel lintels as scheduled and as detailed on Drawings. Qualify welding processes and welding operators in accordance with American Welding Society D1.1

Structural Welding Code – Steel and IBC 2009, Chapter 22 Steel.

2. Do not weld lintels to bearing plates at masonry wall control joint locations.
3. Construct beam block lintels using grout fill and reinforcing specified. Place two #5 reinforcing bars 1 inch from bottom web, for openings up to 42 inch wide. Reinforce larger openings as detailed.
4. Use reinforcing bars of 1 piece lengths only.
5. Place and consolidate grout fill without disturbing reinforcing.
6. Allow lintels to reach strength before removing temporary supports.
7. At bearing points, fill masonry cores with grout fill minimum 12 inch from opening.
8. Lintel information of this section also applies to bond beams.

G. CONTROL AND EXPANSION JOINTS

1. Do not continue horizontal joint reinforcing across control joints. Bond beam reinforcing bars are to run continuous across control joints.
2. Install preformed control device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's recommendations.
3. Size control joints in accordance with Section 079200 for sealant performance.
4. Install joint stabilizing anchors at expansion joints per manufacturer's recommendations.

H. BUILT-IN WORK

1. As work progresses, build-in metal door frames, fabricated metal frames, window frames, wood nailing strips, anchor bolts, plates, reglets and other items to be built in work supplied by other Sections.
2. Build-in items plumb and level.
3. Bed anchors of metal door and glazed frames in mortar joints. Fill frame voids solid with mortar. Fill masonry cores with grout minimum 8 inch from framed openings.
4. Do not build-in organic materials subject to deterioration.

I. CUTTING AND FITTING

1. Cut and fit masonry units for chases, pipes, conduit, sleeves, ductwork, door and window openings. Cooperate fully with other Sections of work to ensure correct size, shape and

location.

2. Obtain A/E's review prior to cutting or fitting any area not indicated on Drawings or which may impair appearance or strength of masonry work.

2.0 MATERIALS

A. Face Brick:

1. Shall be modular or standard and comply with ASTM C-216, Grade SW, Type FBX, except C/B ratio requirements are not waived for higher strength units.
2. Physical properties of face brick used shall conform to the following specific requirements:

Test	Units	Average of 5 Bricks	Individual
Compressive Strength	psi	8,900 min.	6,000 min.
Modulus of Rupture	psi	900 min.	800 min.
Water Absorption (24 hour cold)	percent	6 max.	8 max.
Water Absorption (5 hour boil)	percent	8 max.	10 max.
Rate of Absorption	grams per minute per 30 square inches	5 min.	3 min.
Rate of Absorption	grams per minute per 30 square inches	20 max.	25 max.
Efflorescence	-----	None	None
Must meet one of the following two requirements:			
C/B Ratio		0.75 max.	0.80 max.
Autoclave Expansion (age of 1 month)	percent	0.10 max.	0.20 max.

B. Salvaged Brick:

1. Shall be obtained from OWNER.

C. Concrete Masonry Units:

1. Concrete Brick: Shall conform to ASTM C-55, Grade N.
2. Load Bearing Concrete Block Masonry Units (CMU): Shall be manufacturer's standard units with nominal face dimensions 16 inch long x 8 inch high (15-5/8 inch x 7-5/8 inch actual). Units shall conform to ASTM C-90 or ASTM C-145, Grade N-I. Lightweight units shall be made with approved aggregate conforming to ASTM C-331. Minimum compressive strength to be 3000psi.
3. Special Shapes: Provide special shapes where shown and where required for lintels, corners, jambs, control joints, headers, bonding and other special conditions.
4. Provide bullnose block for exposed outside corners on interior partitions and pilasters unless noted otherwise. Window openings receiving hollow metal or aluminum frames are to have square corners. Door openings to have bullnose corners where detailed on Drawings.

D. Glass Blocks Units:

1. Shall be partially evacuated, hollow masonry units made of clear, colorless glass without a highly reflective oxide surface coating. Shape and size shall be as detailed on Drawings.

E. Cut Stone:

1. Stone trim around windows and at wall cap shall be smooth textured Indiana limestone of size and profile as detailed on Drawings. Color shall be selected by A/E.

3.0 PRE-APPROVED MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work, include, but are not limited to, the following:

1. As noted throughout this section.

B. Substitutions /or Equal: If alternative manufacturers other than the pre-approved manufacturer are proposed for any specified equipment in this section, the CONTRACTOR/bidder must supply a submittal, refer to STS 01 33 00.

C. Although the brands listed herein are the preferred brands, it is not the intent of the OWNER for these specifications to be proprietary; equals will be evaluated in accordance with comparable quality, construction, strength, durability, and suitability for the purpose intended and are listed for the purpose of describing the standard of quality performance and characteristics.

D. Manufacturers listed in this specification do not constitute approval. All equipment must have the capabilities and functions as specified herein.

PART 3: EXECUTION

1.0 CONTRACTOR'S RESPONSIBILITY

A. The CONTRACTOR is responsible for furnishing and installing the PRODUCT including all site preparation, and other items necessary for the proper installation and operation of the PRODUCT.

2.0 EXAMINATION

A. Examine all products for compliance with this section.

B. Proceed with installation only after unsatisfactory conditions have been corrected

C. Inspect work of other Sections on which or to which unit masonry is to be built, supported or attached, to determine completeness and proper alignment to receive unit masonry. Do not commence Work until defective Work has been corrected.

3.0 PREPARATION

A. Verify items provided by other Sections of Work are properly sized and located.

B. Establish lines, levels and coursing. Protect from disturbance.

- C. Provide temporary bracing during erection of masonry work. Maintain in place until building structure provides permanent bracing.
- D. Protect CMUs from rain or other moisture to ensure they do not absorb moisture. Top of unfinished walls shall be covered to protect them from weather

4.0 INSTALLATION

A. REPAIR, POINTING AND CLEANING

1. Remove and replace masonry units as directed by A/E which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.
2. POINTING: During tooling of joints, enlarge voids or holes, except weep holes, and completely fill with mortar. Point-up joints at corners, openings and adjacent work to provide a neat, uniform appearance, properly prepared for application of caulking or sealant compounds.
3. Clean exposed brick masonry surfaces as recommended by BIA Technical Notes 20 "Cleaning Clay Products Masonry". Procedure "B".
4. Clean exposed CMU masonry by dry brushing at end of each day's work and after final pointing to remove mortar spots and droppings.

B. TESTING

1. Provide for testing, masonry prisms constructed per ASTM E-447. Build test prisms where they will not be moved or disturbed before testing. Build 1 prism per each 5 days of load bearing masonry construction.

5.0 OPERATIONS AND MAINTENANCE MANUALS

- A. Per Specification 01 77 23, the Manufacturer shall provide 5 copies of the operations and maintenance manuals which shall include the assembly and installation instructions. Operation and maintenance instructions which rely on vendor cut-sheets and literature which include general configurations, or require operating personnel to selectively read portions of the manual shall not be acceptable. Operation and maintenance instructions must be specific to equipment supplied in accordance with these specifications.

6.0 WARRANTY

- A. The PRODUCT and work shall be warranted against defects in material and workmanship for a period of one year. The warranty period shall begin after final inspection and acceptance by the project ENGINEER.

END OF SECTION

SUPPLEMENTAL SECTION 04 22 35

REINFORCED BLOCK MASONRY

PART 1: GENERAL

1.0 SUMMARY

- A. Applicable provisions of Division 01 shall govern work of this Section.
- B. Include materials, labor, services and incidentals necessary for completion of this Section of Work.
- C. Extent of unit masonry work is indicated on Drawings.

2.0 REFERENCES AND DEFINITIONS

A. Industry Standards, Specifications and Codes:

1. General:

- a) Comply with provisions of the following codes and standards except as modified.
- b) Referenced codes and standards including revisions and commentaries shall be the most currently adopted as of the date of these Contract Documents.

2. American National Standards Institute (ANSI):

- a) A41.1 Building Code Requirements for Masonry

3. American Society for Testing and Materials (ASTM):

- a) Additional Specific ASTM numbers are noted in later text

4. American Concrete Institute (ACI):

- a) ACI 530-05 Building Code Requirement for Masonry Structures
- b) ACI 530.1-05 Specifications for Masonry Structures

5. National Concrete Masonry Association (NCMA)

6. The Brick Institute Of America (BIA)

7. International Building Code (IBC) – 2009

B. RELATED SECTIONS

1. Section 040516 – Masonry Grouting
 2. Section 040523 - Masonry Accessories
 3. Section 042000 - Unit Masonry
- C. Where all or part of a Federal, ASTM, ANSI, AWWA, and Arizona Uniform Standard Specification for Public Works Construction etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.

3.0 SUBMITTALS

- A. General: Submit listed submittals in accordance with conditions of the Contract and with Specification 01 33 00.
- B. Product Data: Submit product data, including manufacturer's specifications, installation instructions, and general recommendations for installation. Also include manufacturer's certification or other data substantiating that products comply with requirements of Contract Documents. Clearly identify product/model to be used.
- C. Test Reports: Submit for acceptance, complete test reports from approved independent testing laboratories certifying that product conforms to performance characteristics and testing requirements specified herein.
- D. Shop drawings: Submit clear, concise drawing showing model number, size, arrangement and configuration of all products specified. Minimum sheet size is 8.5" X 11".

4.0 QUALITY ASSURANCE

A. Tolerances

1. Dimension of Elements:

- a) In Cross Section or Elevation: minus 1/4 inches, plus 1/2 inches
- b) Mortar Joint Thickness:
 - i. Bed Joint: plus/minus 1/8 inches
 - ii. Head Joint: minus 1/4 inches, plus 3/8 inches
 - iii. Collar: minus 1/4 inches plus 3/8 inches
- c) Grout space or cavity width, except for masonry walls passing framed construction: minus 1/4 inches, plus 3/8 inches

B. Elements:

1. Variation from Level:

- a) Bed Joints: plus/minus 1/4 inches in 10 feet, plus/minus 1/2 inches maximum
 - i. Top Surface of Bearing Walls: plus/minus 1/4 inches in 10 feet, plus/minus 1/2 inches maximum
 - 2. Variation from Plumb: plus/minus 1/4 inches in 10 feet, plus/minus 3/8 inches in 20 feet, plus/minus 1/2" maximum
 - 3. True to a Line: plus/minus 1/4 inches in 10 feet, plus/minus 3/8" inches in 20 feet, plus/minus 1/2" maximum
 - 4. Alignment of Columns and Walls (bottom versus top):
 - a) Bearing Walls: plus/minus 1/2 inches
 - b) Non- Bearing Walls: plus/minus 3/4 inches
- C. Location of Elements:
- 1. Indicated in Plan: plus/minus 1/2 inches in 20 feet, plus/minus 3/4 inches maximum
 - 2. Indicated in Elevation: plus/minus 1/4 inches in story height, plus/minus 3/4 inches maximum
- D. Mock-Up:
- 1. Provide mock-up panel for approval prior to proceeding with work.
 - 2. Remove panel when directed by ENGINEER. Approved panel may be incorporated into work at discretion of ENGINEER.
- E. Clean completed work as work progresses to avoid excessive final cleaning.
- F. Maintain protective boards at exposed external corners which may be damaged by construction activities.
- G. Provide protection without damaging completed work.
- H. At day's end, cover unfinished walls to prevent moisture infiltration.

5.0 STORAGE AND HANDLING

- A. The CONTRACTOR shall be responsible for the safe storage of the equipment until it is incorporated in the completed project.
- B. Carefully pallet or neatly stack undamaged brick and block on the site. Protect brick and block from weather and construction activities. Upon delivery of block to job site, compare with approved sample and report deviations immediately to OWNER. Conform to requirements specified. Cull-out, credit and immediately remove defective block from site. Re-sort or cull brick units, especially when plant palletted to avoid spotty or irregular ranges of color or texture in finished wall.

PART 2: PRODUCTS

1.0 SPECIFICATIONS & MATERIALS

A. MASONRY MATERIALS

1. Concrete Masonry Units:

a) Concrete Block Masonry Units: (CMU)

- i. Shall be manufacturer's standard units with nominal face dimensions 16 inches long by 8 inches high (15-5/8 inches by 7-5/8 inches actual). Units shall conform to ASTM C-90. Lightweight units shall be made with approved aggregate conforming to ASTM C-331. Lightweight units shall only be used where noted on plan. Minimum compressive strength to be 3000psi.

b) Special Shapes:

- i. Provide where required for lintels, corners, jambs, control joints, headers, bonding and other special conditions.

2. MASONRY LINTELS

- a) Prefabricated or built-in-place masonry lintels made from bond beam concrete masonry units with reinforcing bars placed according to structural drawings., or if not shown on drawings, according to the in schedule below, and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

b) Concrete Masonry Unit Lintel Reinforcement Schedule (for non-load bearing masonry walls):

<u>CMU Width</u>	<u>Opening Width (Maximum)</u>	<u>Lintel Reinforcement</u>
6"	3'-4"	1 - #4
6"	7'-4"	1 - #5
8"	3'-4"	2 - #4
8"	7'-4"	2 - #5
12"	3'-4"	2 - #4
12"	7'-4"	2 - #5

B. MORTAR AND GROUT MATERIALS

1. Provided under Section 040516- Masonry Grouting.

C. STEEL REINFORCING MATERIALS

1. Reinforcing bars are provided under Division 03.
2. Masonry Joint Reinforcement, General: ASTM A 951.
3. Interior Walls: Mill-galvanized, carbon steel.
4. Exterior Walls: Hot-dip galvanized, carbon steel.
5. Wire Size for Side Rods: W1.7 or 0.148-inch diameter.
6. Wire Size for Cross Rods: W1.7 or 0.148-inch diameter.
7. Wire Size for Veneer Ties: W1.7 or 0.148-inch diameter.
8. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
9. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.
10. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.
11. Masonry Joint Reinforcement for Cavity Walls: Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate ties that extend into facing wythe. Ties have two hooks that engage eyes or slots in reinforcement and resist movement perpendicular to wall. Ties extend at least halfway through facing Wythe but with at least 5/8-inch cover on outside face.

D. TIES AND ANCHORS

1. Materials:

- a) Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.
 - b) Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M.
2. Corrugated Metal Ties: Metal strips not less than 7/8 inch wide with corrugations made from steel sheet, galvanized after fabrication not less than 0.053 inch thick.
3. Adjustable Anchors for Connecting to Structure: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
 - a) Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- diameter, hot-dip galvanized steel wire.
 - b) Connector Section for Concrete: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.053-inch- thick, steel sheet, galvanized after fabrication.
 - c) Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.188-inch-diameter, hot-dip galvanized steel wire.
4. Adjustable Masonry-Veneer Anchors: Provide screw-attached units consisting of a wire tie and a metal anchor section that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs. Units to be capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch. Fabricate sheet metal anchor sections from 0.067-inch- thick, steel sheet, galvanized after fabrication.
5. Provide one of the following anchor sections:
 - a) Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, 2-3/4 inches wide by 3 inches high; with projecting tabs having slotted holes for inserting vertical legs of wire tie specially formed to fit anchor section.
 - b) Anchor Section: Sheet metal plate, 1-1/4 inches wide by 6 inches long, with screw holes top and bottom and with raised rib-stiffened strap, 5/8 inch wide by 3-5/8 inches long, stamped into center to provide a slot between strap and plate for inserting wire tie.
6. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.188-inch-diameter, hot-dip galvanized steel wire.
 - a) Products:
 - i. Dayton Superior Corporation, Dur-O-Wal Division; D/A 213 or D/A 210 with D/A 700-708.

- ii. Heckmann Building Products Inc.; 315-D with 316.
 - iii. Hohmann & Barnard, Inc.; DW-10HS.
 - iv. Wire-Bond; 1004, Type III or RJ-711.
7. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 diameter by length required to penetrate steel stud flange with not less than 3 exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.
- a) Available Products:
 - i. ITW Buildex; Teks Maxiseal with Climaseal finish.
 - ii. Textron Inc., Textron Fastening Systems; Elco Dril-Flex with Stalgard finish.

2.0 PRE-APPROVED MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work, include, but are not limited to, the following:
 - 1. As noted throughout this section.
- B. Substitutions /or Equal: If alternative manufacturers other than the pre-approved manufacturer are proposed for any specified equipment in this section, the CONTRACTOR/bidder must supply a submittal, refer to STS 01 33 00.
- C. Although the brands listed herein are the preferred brands, it is not the intent of the OWNER for these specifications to be proprietary; equals will be evaluated in accordance with comparable quality, construction, strength, durability, and suitability for the purpose intended and are listed for the purpose of describing the standard of quality performance and characteristics.
- D. Manufacturers listed in this specification do not constitute approval. All equipment must have the capabilities and functions as specified herein.

PART 3: EXECUTION

1.0 CONTRACTOR'S RESPONSIBILITY

- A. The CONTRACTOR is responsible for furnishing and installing the PRODUCT including all site preparation, and other items necessary for the proper installation and operation of the PRODUCT.

2.0 EXAMINATION

- A. Examine all products for compliance with this section.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

- C. Examine work of other sections on which or to which unit masonry is to be built, supported or attached to determine completeness and proper alignment to receive unit masonry. Do not commence work until defective work has been corrected.

3.0 PREPARATION

- A. Verify items provided by other Sections of work are properly sized and located.
- B. Establish lines, levels and coursing. Protect from disturbance.
- C. Provide temporary bracing during erection of masonry work. Maintain in place until building structure provides permanent bracing.

4.0 INSTALLATION

A. GENERAL

- 1. Reinforced hollow unit masonry is that type of construction made with hollow masonry units in which certain cells are continuously filled with grout, and in which reinforcement is embedded. Only Type M or Type S mortar consisting of a mixture of portland cement, hydrated lime and aggregate shall be used.

B. CONSTRUCTION REQUIREMENTS

- 1. Horizontal joint reinforcement is required for single Wythe CMU walls and 2-wythe brick/CMU cavity walls. Minimum horizontal reinforcement shall be standard ladder-type with #9 gage side rods and cross rods. Spacing shall be 16 inches o.c. or less if coursing is not in 8 inch module.
- 2. Reinforced hollow unit masonry shall be built to preserve unobstructed vertical continuity of cells to be filled. Walls and cross webs forming cells to be filled shall be full-bedded in mortar to prevent leakage of grout. Bond shall be provided by lapping units in successive vertical courses. Laps shall be in accordance with ACI 318.
- 3. Vertical cells to be filled shall have vertical alignment to maintain a clear, unobstructed continuous vertical cavity with measurements as specified in Section 040516- Masonry Grouting.
- 4. Cleanout openings shall be provided at the bottom of cells to be filled at each pour of grout where grout pour is in excess of 5 feet in height. Overhanging mortar or other obstruction or debris shall be removed from insides of cell walls. Cleanouts shall be sealed before grouting, after inspection.
- 5. Vertical cells containing reinforcement shall be filled solidly with grout. Grout shall be poured in lifts with maximum height as specified in Section 040516- Masonry Grouting. Grout shall be consolidated at time of pouring by puddling or vibrating and then reconsolidated again by puddling after initial water loss and settlement has occurred, before

plasticity is lost.

6. At time of placement, grout shall have a minimum slump of 8 inches.
7. When grouting is stopped for 1 hour or longer, horizontal construction joints shall be formed by stopping pour of grout not less than 1/2 inches below top of uppermost unit grouted.
8. Grout compressive strength shall be greater than or equal to specified compressive strength of masonry units.

C. COURSING

1. Place masonry to lines and levels indicated.
2. Maintain masonry courses to uniform width. Make vertical and horizontal joints equal and of uniform thickness.
3. Lay concrete masonry units in running bond. Course 1 block unit and 1 mortar joint to equal 8 inches. Form concave mortar joints in exposed to view surfaces and flush elsewhere.

D. PLACING AND BONDING

1. Use standard size CMU throughout.
2. Construct face CMU piers between windows using both standard and modular units to maintain uniform joints.
3. Patch, in-fill and tooth at existing building, using colored mortar (if required to match).
4. Lay masonry in full bed of mortar, properly jointed with other work. Buttering corners of joints and deep or excessive furrowing of mortar joints not permitted.
5. Fully bond intersections and external and internal corners.
6. Do not shift or tap masonry units after mortar has taken initial set. Where adjustment must be made, remove mortar and replace.
7. Remove excess mortar.
8. Perform jobsite cutting with proper tools to provide straight unchipped edges. Take care to prevent breaking masonry unit corners or edges.
9. Cut mortar joints of masonry units flush where resilient base is scheduled or cavity insulation vapor barrier adhesive is applied.
10. Isolate masonry partitions from vertical structural framing members with a control joint.

11. The top course of walls and course directly under location of steel joist bearing unless otherwise noted shall be a bond beam filled with grout (not concrete) with two #5 reinforcing bars continuous.
12. Pilasters noted shall be filled solid with grout (not concrete) and include four #4 reinforcing bars minimum vertical unless noted otherwise.

E. CAVITY WALL

1. Do not let mortar fall into cavity air space, control joint voids or plug weep holes; clean out promptly.
2. Fill concrete block units with insulation when indicated on Drawings.
3. Install weep ventilators in veneer at 24 inches on center horizontally above through-wall flashing, above shelf angles and at bottom of walls.
4. Install building paper over insulation or sheathing.

F. LINTELS

1. Install loose steel lintels as scheduled and as detailed.
2. Construct beam block lintels using grout fill and reinforcing specified. Place reinforcing bars 1 inch from bottom web. Reinforce openings as detailed.
3. Use reinforcing bars of 1 piece lengths only.
4. Place and consolidate grout fill without disturbing reinforcing.
5. Allow lintels to reach strength before removing temporary supports.
6. At bearing points, fill masonry cores with grout fill minimum 12 inches from opening.
7. Lintel information of this Section also applies to bond beams.

G. CONTROL JOINTS

1. Do not continue horizontal joint reinforcing across control joints.
2. Form control joints as work progresses, minimum 1/2 inches wide or as detailed. Use removable joint form providing positive bond break and preventing accumulation of mortar droppings.
3. Remove form and leave joint free and clear of obstructions.

H. BUILT-IN WORK

1. As work progresses, build-in metal door frames, fabricated metal frames, window frames, wood nailing strips, anchor bolts, plates, reglets and other items to be built in work supplied by other Sections.
2. Build-in items plumb and level.
3. Bed anchors of metal door and glazed frames in mortar joints. Fill frame voids solid with mortar. Fill masonry cores with grout minimum 8 inches from framed openings.
4. Do not build-in organic materials subject to deterioration.

I. CUTTING AND FITTING

1. Cut and fit masonry units for chases, pipes, conduit, sleeves, ductwork, door and window openings. Coordinate size, shape and location with other sections of work.
2. Obtain A/E's review prior to cutting or fitting areas not indicated on Drawings or which may impair appearance or strength of masonry work.

J. REPAIR, POINTING AND CLEANING

1. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.
2. POINTING: During tooling of joints, enlarge voids or holes, except weep holes and completely fill with mortar. Point-up joints at corners, openings and adjacent work to provide a neat, uniform appearance, properly prepared for application of calking or sealant compounds.
3. Clean exposed CMU masonry by dry brushing at end of each day's work and after final pointing to remove mortar spots and droppings.

5.0 OPERATIONS AND MAINTENANCE MANUALS

- A. Per Specification 01 77 23, the Manufacturer shall provide 5 copies of the operations and maintenance manuals which shall include the assembly and installation instructions. Operation and maintenance instructions which rely on vendor cut-sheets and literature which include general configurations, or require operating personnel to selectively read portions of the manual shall not be acceptable. Operation and maintenance instructions must be specific to equipment supplied in accordance with these specifications.

6.0 WARRANTY

- A. The PRODUCT and work shall be warranted against defects in material and workmanship for a period of one year. The warranty period shall begin after final inspection and acceptance by the project ENGINEER.

END OF SECTION

SUPPLEMENTAL SECTION 07 92 00

JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes joint sealants for the following applications, including those specified by reference to this Section:
 - 1. Exterior joints in the following vertical surfaces and horizontal non-traffic surfaces:
 - a. Construction joints in cast-in-place concrete.
 - b. Control and expansion joints in unit masonry.
 - c. Joints in exterior insulation and finish systems.
 - d. Joints between different materials listed above.
 - e. Perimeter joints between materials listed above and frames of doors, windows and, louvers.
 - f. Control and expansion joints in ceilings and other overhead surfaces.
 - 2. Exterior joints in the following horizontal traffic surfaces:
 - a. Isolation and contraction joints in cast-in-place concrete slabs.
 - b. Joints between different materials listed above.
 - c. Other joints as indicated.
 - 3. Interior joints in the following vertical surfaces and horizontal non-traffic surfaces:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings where indicated.
 - c. Tile control and expansion joints.
 - d. Perimeter joints between interior wall surfaces and frames of interior doors, windows and elevator entrances.
 - e. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - 4. Interior joints in the following horizontal traffic surfaces:
 - a. Isolation joints in cast-in-place concrete slabs.
 - b. Control and expansion joints in tile flooring.
 - c. Other joints as indicated.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

- B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.4 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.
- D. Qualification Data: For Installer and testing agency.
- E. Product Test Reports: Based on comprehensive testing of product formulations performed by a qualified testing agency, indicating that sealants comply with requirements.
- F. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.6 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 - 2. When joint substrates are wet.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

- A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.
- B. Substitutions /or Equal: If alternative manufacturers other than the pre-approved manufacturer listed in either the supplemental or standard specification are proposed, the CONTRACTOR must supply a submittal, refer to Supplemental Technical Specification 01 33 00, paragraph 14.

2.2 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.3 ELASTOMERIC JOINT SEALANTS

- A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing 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 elastomeric sealants are specified to be non-staining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- C. Suitability for Immersion in Liquids. Where elastomeric sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247 and qualify for the length of exposure indicated by reference to ASTM C 920 for Class 1 or 2. Liquid used for testing sealants is de-ionized water, unless otherwise indicated.
- D. Single-Component Pourable Neutral-Curing Silicone Sealant :
 1. Products:
 - a. Dow Corning Corporation; 890-SL.
 - b. Pecora Corporation; 300 Pavement Sealant (Self Leveling).
 - c. Dow Corning Corporation; SL Parking Structure Sealant.
 2. Type and Grade: S (single component) and P (pourable).

3. Class: 100/50
 4. Use[s] Related to Exposure: NT and T (traffic).
 5. Uses Related to Joint Substrates: M, A, and O, as applicable to joint substrates indicated.
 - a. Use O Joint Substrates: Galvanized steel and ceramic tile.
- E. Single-Component Mildew-Resistant Neutral-Curing Silicone Sealant:
1. Products:
 - a. Pecora Corporation; 898.
 - b. Tremco; Tremsil 600 White.
 2. Type and Grade: S (single component) and NS (nonsag).
 3. Class: 25.
 4. Use Related to Exposure: NT (nontraffic).
 5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.
 - a. Use O Joint Substrates: Coated glass, color anodic aluminum, galvanized steel, ceramic tile.
- F. Multicomponent Nonsag Urethane Sealant :
1. Products:
 - a. Pecora Corporation; Dynatrol II.
 - b. Tremco; Dymeric 511.
 - c. Tremco; Vulkem 922.
 2. Type and Grade: M (multicomponent) and NS (nonsag).
 3. Class: 50.
 4. Use[s] Related to Exposure: NT (nontraffic) and T (traffic).
 5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.
 - a. Use O Joint Substrates: galvanized steel, ceramic tile, and wood.
- G. Multicomponent Pourable Urethane Sealant:
1. Products:
 - a. Bostik Findley; Chem-Calk 550.
 - b. Pacific Polymers, Inc.; Elasto-Thane 227 High Shore Type I (Self Leveling). c. Pacific Polymers, Inc.; Elasto-Thane 227 Type I (Self Leveling).
 - d. Polymeric Systems Inc.; PSI-270SL.
 - e. Schnee-Morehead, Inc.; Permathane SM 7201.
 - f. Tremco; THC-901.
 - g. Tremco; Vulkem 245.
 - h. Pecora Corporation; Urexpam NR 300, Type H.
 2. Type and Grade: M (multicomponent) and P (pourable).
 3. Class: 25.
 4. Use Related to Exposure: T (traffic).
 5. Uses Related to Joint Substrates: M, A, and, as applicable to joint substrates indicated, O.
 - a. Use O Joint Substrates: galvanized steel, ceramic tile, and wood.
- H. Single-Component Nonsag Urethane Sealant :
1. Products:
 - a. Sika Corporation, Inc.; Sikaflex - 1a.
 - b. Sonneborn, Division of ChemRex Inc.; Ultra. c. Sonneborn, Division of ChemRex Inc.; NP 1.
 - d. Tremco; Vulkem 116.

2. Type and Grade: S (single component) and NS (non-sag).
3. Class: 25.
4. Uses Related to Exposure: T (traffic) and NT (non-traffic).
5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.
 - a. Use O Joint Substrates: aluminum coated with a high-performance coating, galvanized steel, ceramic tile and wood.

2.4 SOLVENT-RELEASE JOINT SEALANTS

- A. Acrylic-Based Solvent-Release Joint Sealant: Comply with ASTM C 1311 or FS TT-S-00230.
 1. Products:
 - a. Schnee-Moorehead, Inc.; Acryl-R Acrylic Sealant.
 - b. Tremco; Mono 555.
- B. Butyl-Rubber-Based Solvent-Release Joint Sealant: Comply with ASTM C 1085.
 1. Products:
 - a. Bostik Findley; Bostik 300.
 - b. Fuller, H. B. Company; SC-0296. c. Fuller, H. B. Company; SC-0288.
 - d. Pecora Corporation; BC-158.
 - e. Polymeric Systems Inc.; PSI-301
 - f. Sonneborn, Division of ChemRex Inc.; Sonneborn Multi-Purpose Sealant.
 - g. Tremco; Tremco Butyl Sealant.

2.5 LATEX JOINT SEALANTS

- A. Latex Sealant: Comply with ASTM C 834, Type P, Grade NF. B.

Products:

 1. Bostik Findley; Chem-Calk 600.
 2. Pecora Corporation; AC-20+.
 3. Schnee-Morehead, Inc.; SM 8200.
 4. Sonneborn, Division of ChemRex Inc.; Sonolac.
 5. Tremco; Tremflex 834.

2.6 ACOUSTICAL JOINT SEALANTS

- A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C 834 and the following:
 1. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 2. Products:
 - a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant. b. United States Gypsum Co.; SHEETROCK Acoustical Sealant.

2.7 PREFORMED JOINT SEALANTS

- A. Preformed Foam Sealant: Manufacturer's standard preformed, pre-compressed, open-cell foam sealant that is manufactured from high-density urethane foam impregnated with a

nondrying, water-repellent agent; is factory produced in pre-compressed sizes in roll or stick form to fit joint widths indicated; is coated on one side with a pressure-sensitive adhesive and covered with protective wrapping; develops a watertight and airtight seal when compressed to the degree specified by manufacturer; and complies with the following:

1. Products:
 - a. EMSEAL Joint Systems, Ltd.; Emseal 25V. b. illbruck Sealant Systems, Inc.; Wilseal 600.
 - c. Polytite Manufacturing Corporation; Polytite B.
 - d. Polytite Manufacturing Corporation; Polytite Standard.
 - e. Sandell Manufacturing Co., Inc.; Polyseal.
2. Properties: Permanently elastic, mildew resistant, non-migratory, non-staining, and compatible with joint substrates and other joint sealants.
 - a. Density: 10 lb/cu. ft..

2.8 PREFORMED TAPE SEALANTS

- A. Back-Bedding Mastic Tape Sealant: Preformed, butyl-based elastomeric tape sealant with a solids content of 100 percent; non-staining and non-migrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
 1. AAMA 804.3 tape, where indicated.
 2. AAMA 806.3 tape, for applications in which tape is subject to continuous pressure.
 3. AAMA 807.3 tape, for applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Tape Sealant: Closed-cell, PVC foam tape sealant; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types:
 1. Type 1, for applications in which tape acts as the primary sealant.
 2. Type 2, for applications in which tape is used in combination with a full bead of liquid sealant.

2.9 JOINT-SEALANT BACKING

- A. General: Provide sealant backings of material and type that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), O (open-cell material) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
- C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26 deg F. Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and to otherwise contribute to optimum sealant performance.
- D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler

materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self- adhesive tape where applicable.

2.10 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, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint- sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.

- b. Glass.
 - c. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates, where recommended in writing by joint-sealant manufacturer, based on 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 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.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Acoustical Sealant Application Standard: Comply with recommendations in ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.
- D. Install sealant backings of type 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.
- E. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- F. 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.
- G. Tooling of Non-sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified 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 configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
 4. Provide flush joint configuration where indicated per Figure 5B in ASTM C 1193.
 5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 5C in ASTM C 1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.
- H. Installation of Preformed Tapes: Install according to manufacturer's written instructions.
- I. Installation of Preformed Silicone-Sealant System: Comply with the following requirements:
1. Apply masking tape to each side of joint, outside of area to be covered by sealant system.
 2. Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone-sealant system manufacturer's written instructions and covering a bonding area of not less than 3/8 inch. Hold edge of sealant bead 1/4 inch inside masking tape.
 3. Within 10 minutes of sealant application, press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact between sealant and both extrusion and substrate.
 4. Complete installation of sealant system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.
- J. Installation of Preformed Foam Sealants: Install each length of sealant immediately after removing protective wrapping, taking care not to pull or stretch material, producing seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures where expansion of sealant requires acceleration to produce seal, apply heat to sealant in compliance with sealant manufacturer's written instructions.

3.4 CLEANING

- A. 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.

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior vertical and horizontal non-traffic construction joints in cast-in-place concrete.
 - 1. Joint Sealant: Multicomponent non-sag urethane.
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.

- B. Joint-Sealant Application: Exterior joints in exterior insulation and finish systems.
 - 1. Joint Sealant: Multicomponent non-sag urethane sealant.
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.

- C. Joint-Sealant Application: Exterior vertical joints between different materials listed above.
 - 1. Joint Sealant: Multicomponent non-sag urethane sealant.
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.

- D. Joint-Sealant Application: Exterior perimeter joints between EFIS and frames of doors, and windows.
 - 1. Joint Sealant: Multicomponent non-sag urethane sealant.
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.

- E. Joint-Sealant Application: Exterior control and expansion joints in overhead surfaces.
 - 1. Joint Sealant: Multicomponent non-sag urethane sealant].
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.

- F. Joint-Sealant Application: Interior perimeter joints of exterior openings.
 - 1. Joint Sealant: Multicomponent non-sag urethane sealant.
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.
 - 3. If Project includes more than one type of ceramic tile or dimension stone tile and each type requires a different color and type of joint sealant, duplicate first paragraph and subparagraphs below and revise to indicate specific tile type, joint-sealant type, and color. Delete below if installation of joint sealants for ceramic and dimension stone tile is specified in Division 09 Sections "Tiling" and "Stone Tiling."

- G. Joint-Sealant Application: Interior joints between plumbing fixtures and adjoining walls, floors, and counters.
 - 1. Joint Sealant: Single-component mildew-resistant neutral curing silicone sealant.
 - 2. Joint-Sealant Color: White.

- H. Joint-Sealant Application: Perimeter joints between interior wall surfaces and frames of interior doors, windows.
 - 1. Joint Sealant: Latex sealant.
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.

END OF SECTION 07 92 00

SUPPLEMENTAL SECTION 07 95 01

EXPANSION JOINT SEALANT SYSTEM

PART 1: GENERAL

1.0 SUMMARY

- A. Applicable provisions of Division 01 shall govern work of this section.
- B. Include materials, labor, services and incidentals necessary for the completion of this section of the work.
- C. The work covered under this section consists of installing the expansion joint seals as shown and detailed on the drawings.
- D. The expansion joint blockouts shall be provided as detailed on the drawings and specified under other sections of the specifications.

2.0 REFERENCES AND DEFINITIONS

- A. Manufacturer's Data and Samples
 - 1. Submit in accordance with STS 01 33 00, manufacturer's specifications, recommendations and installation instructions for each type of sealant and associated miscellaneous material required. Include manufacturer's published data, letter of certification or certified test laboratory report indicating that each material complies with the requirements and is intended generally for the applications shown. Show by transmittal that one copy of each recommendation and instruction has been distributed to the installer. Literature, details, samples, shop drawings, warranties, etc. shall be included in the submittal.
- B. Warranty
 - 1. The system manufacturer shall furnish the OWNER with a written single-source performance warranty that the expansion joint sealant system be free of defects related to design, workmanship or material deficiency for a five year period from the date of substantial completion of the work required under this section. The following problems shall be specifically covered under the warranty:
 - a) Adhesive or cohesive failure of the seal.
 - b) Discoloration, crazing or other weathering deficiency of the seal.
 - c) Abrasion or tear failure of the seal resulting from normal traffic use.
 - d) Defective joint installation.

2. Perform repair under this warranty at no cost to the OWNER.
 3. The system manufacturer shall submit a detailed warranty consistent with the terms of this specification prior to construction for approval. The approved warranty shall be made part of the contractual agreement and shall represent the sole warranty statement for the project.
 4. Snowplows, abrasive maintenance equipment, and vandalism and are not normal traffic use and are exempt from the warranty.
 5. Furnish the OWNER with five copies of the snow removal guidelines for the areas covered by this warranty.
- C. Where all or part of a Federal, ASTM, ANSI, AWWA, and Arizona Uniform Standard Specification for Public Works Construction etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.

3.0 SUBMITTALS

- A. General: Submit listed submittals in accordance with conditions of the Contract and with Specification 01 33 00.
- B. Product Data: Submit product data, including manufacturer's specifications, installation instructions, and general recommendations for installation. Also include manufacturer's certification or other data substantiating that products comply with requirements of Contract Documents. Clearly identify product/model to be used.
- C. Test Reports: Submit for acceptance, complete test reports from approved independent testing laboratories certifying that product conforms to performance characteristics and testing requirements specified herein.
- D. Shop drawings: Submit clear, concise drawing showing model number, size, arrangement and configuration of all products specified. Minimum sheet size is 8.5" X 11".

4.0 QUALITY ASSURANCE

- A. Comply with the applicable provisions of the specifications, standards and documents listed under References.

5.0 STORAGE AND HANDLING

- A. The CONTRACTOR shall be responsible for the safe storage of the equipment until it is incorporated in the completed project.

PART 2: PRODUCTS

1.0 SPECIFICATIONS & MATERIALS

A. General

1. The expansion joint seal system shall be a complete system of compatible materials designed by the manufacturer to produce waterproof, traffic-bearing expansion joint seals as detailed on the drawings.
2. Expansion joint seal system must conform to Americans with Disabilities Accessibility Guidelines for Buildings and Facilities.

B. Style

1. Elastomeric concrete edged with extruded rubber sealant systems.
2. "Wabo® Crete II Membrane 201 Expansion Joint System" by Watson Bowman ACME
3. "Thermafex Membrane/Nosing System, Type TCR" by Emseal
4. "Polycrete/Membrane System, Type CR" by Erie Metal Specialties
5. or ENGINEER approved equal

C. Base Bid Expansion Joint

1. Systems approved for use under this section shall be the "Iso-Flex Factory Molded Urethane Expansion Joint Seal" as manufactured by Peterson Elastomers Inc., Engineering.
2. The urethane expansion joint seal shall be factory molded off site under environmentally controlled conditions. The seal shall have low modulus, high elongation properties, (durometer: Shore A, 30 +/- 5).
3. The system shall include the use of polymeric nosings consisting of a hard, abrasion resistant polymeric compound designed to protect against concrete edge spalling. The compound shall be a two-component polymer designed for rapid cure with higher durometer than the factory molded seal.
4. Nosings, traffic plates, blockout fillers, bond breakers, primers and miscellaneous materials required for installation shall be as recommended by the manufacturer.
5. Materials used in each of these sections shall be compatible with each other.
6. The joint sealant shall satisfy the requirements of Federal Specification TT-S-00227E, sealants Class A, Type 1 and the requirements of ASTM C920, Type M, Grade P, Class 25.
7. Materials shall be modified polyurethanes containing no coal tar, asphalt or other adulterants.

D. Alternate Expansion Joint

1. Alternate system approved for use under this section shall be the "Tremco" Continuous Span Mechanical Expansion Joint by "Fel-Span-CS".
 2. Fel-Span-CS shall be compounded by Fel-Pro of 60 durometer elastomer to make the system practically unaffected by low temperatures. The system shall retain its shock-absorption properties during winter months and resist wear and abrasion.
 3. The joint shall have a flexible, fabric reinforced, continuous one piece convolution, linking the pads and spanning the expansion joint. The convolution shall absorb building movements while transmitting only minimal forces to the structure. The convolution shall permit both horizontal/vertical and skewed movement while still maintaining its seal. The convolution shall resist puncturing and shall not rip.
 4. High-strength steel reinforcement shall be molded within the pads to provide rigidity to restrict pads from bowing when bolted to the deck, to provide lateral strength to minimize deflections and creep and to keep the pad firmly in place when it is subjected to extraordinary shock.
 5. Grooved, chevron-patterned treads shall be molded into the surface of Fel-Span-CS to provide water drainage. Bolt holes shall be reinforced with 90 durometer elastomer molded at the bottom of each bolt hole.
 6. Joint seal system shall be provided with torque limiting nuts, snow plow guards and an epoxy grouted bolt system.
- E. Substitution/OR EQUAL: if an alternative manufacturer other than the pre-approved manufacturers is proposed for any specialized equipment in this section, the CONTRACTOR must supply a submittal; refer to STS 01 33 00.

PART 3: EXECUTION

1.0 CONTRACTOR'S RESPONSIBILITY

- A. The CONTRACTOR is responsible for furnishing and installing the PRODUCT including all site preparation, and other items necessary for the proper installation and operation of the PRODUCT.

2.0 EXAMINATION

- A. Examine all products for compliance with this section.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. The system manufacturer shall review and approve joint layouts, methods of providing joints, concrete finishing and curing methods and related details prior to construction.
- D. The seal system manufacturer shall assume direct contractual responsibility for installation of the seal system.

3.0 PREPARATION

- A. A blockout of the size detailed shall be provided by the Concrete CONTRACTOR. It shall be the responsibility of the Concrete CONTRACTOR to provide blockouts with clean, sound substrates free of voids and honeycomb and in accordance with dimensions detailed in the drawings and per manufacturer's requirements.
- B. If blockout is not as detailed, inform the Concrete CONTRACTOR for rework of the blockout to meet detailed dimensions.
- C. Concrete CONTRACTOR shall be responsible for protecting blockout and removal of foreign material which might impair expansion joint performance. Expansion joint CONTRACTOR shall perform final cleaning and sandblasting or physical abrading of surface. Commencing of work by expansion joint CONTRACTOR shall constitute acceptance.
- D. A site inspection shall be made by authorized personnel prior to commencing installation of the system for the purpose of reviewing and approving related conditions affecting performance requirements of this specification.
- E. Work shall not proceed until unsatisfactory conditions have been corrected in a manner acceptable to the installer.
- F. Joint edges shall have a tooled radius.

4.0 INSTALLATION

- A. Work shall not proceed under adverse weather conditions or when temperatures are below or above manufacturer's recommended limitations for installation.
- B. Installation procedures shall be in accordance with the system manufacturer's written instructions.
- C. Joints shall be protected from water immersion (due to rain, snow or other work) during the initial installation.
- D. The expansion joint seal system shall be protected from traffic until completely cured.
- E. Prior to opening to traffic, test joint seal for leaks by keeping seal continuously wet for 2 hours. Repair leaks observed by review of underside of seal. Repeat test and repairs until seal is proven to be watertight for 2 hours.

5.0 OPERATIONS AND MAINTENANCE MANUALS

- A. Not used.

6.0 WARRANTY

- A. The PRODUCT and work shall be warranted against defects in material and workmanship for a period of one year. The warranty period shall begin after final inspection and acceptance by the project ENGINEER.

END OF SECTION

**CHINLE WWTP
UPGRADE
ELECTRICAL SPECIFICATIONS
TABLE OF CONTENTS**

16010..... Basic Electrical Requirements

16110..... Raceways

16120..... Wires and Cables (600V or Less)

16130..... Boxes

16140..... Wiring Devices

16195..... Electrical Identification

16250..... Diesel Engine Generators

16260..... Automatic Transfer Switch

16401..... Service Entrance Section

16450..... Grounding

16470..... Panelboards

16475..... Overcurrent Protective Devices

16480..... Mini Power Centers

16481..... Motor Controllers

16500..... Lighting



SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Electrical general provisions as indicated, specified and required for constructing a complete, ready for use electrical system as described in these Contract Documents.
- B. Labor, materials, apparatus, and appliances essential to the complete functioning of systems described and indicated herein, or which may be reasonably implied as essential, whether mentioned in the Contract Documents or not, shall be furnished and installed by the Contractor. In case of doubt as to the work intended, or in the event of need for explanation thereof, Contractor shall refer to the Engineer for supplemental instructions.
- C. All items not specifically mentioned in these Specifications or noted on the Drawings, or on shop drawings, but which are necessary to make a complete and satisfactory, working electrical/instrumentation installation, shall be deemed to be included herein.
- D. All electrical equipment shall be capable of operating successfully at full-rated load, without failure, at an ambient air temperature of -30°C to 50°C, and specifically rated for an altitude of 5460 feet. Where these criteria cannot be met, ancillary equipment and/or special derating factors as approved by the Engineer shall be utilized.
- E. The Contractor shall perform all necessary saw cutting, core drilling, excavating, removal, shoring, backfilling, etc as required for the proper installation of conduits whether inside or outside of the building(s) and structure(s). The Contractor shall repair and patch where demolition has taken place in a manner to match existing original structure.
- F. Since this facility is in continuous operation, the Contractor shall prepare and submit a flow chart and/or written narrative describing the sequence of construction with duration of anticipated power interruptions.

1.02 SUBMITTALS

- A. Submit documentation for review as described in individual Specification Sections for products requiring submission.
- B. Submit Division 16 in one submittal, or at a maximum, the following may be submitted as separate submittals for this project.
 - 1. Commodities (Sections 16010-16195) and Grounding (Section 16450)
 - 2. Standby Generator (16250)
- C. Documentation must be arranged in numerical sequence corresponding with each Specification Section and article of each Section. Soft copies shall be in “pdf”

format with “character recognition” and shall include the following as a minimum:

1. A cover sheet to identify the Contractor’s name, name of the project, date and description, i.e. “Division 16 – Commodities”.
 2. An index corresponding to each specification section with all addendum updates included. Each paragraph or bulleted item shall be check marked to signify compliance with each item and the information is included in the submittal package. If full compliance is not met for any reason, the non-compliance item shall be underlined and reference to a detailed written explanation of the deviation or non-compliance shall be provided in the margin to the right of the specification paragraph or bulleted item for consideration.
 3. Bookmarks within each section for each major component within.
 4. Complete manufacturer name and model number of each item. Listing items “as specified” without both make and model or type designation is not acceptable.
 5. Descriptive Data: complete description, information, and performance data covering materials and equipment that are being proposed. Each component shall be clearly identified on each sheet. Refer to individual specification sections for additional submittal requirements.
- D. If hard copies are provided, they shall be bound in 3-ring binders (2” max) and include all information as described above for soft copies. The binders shall include tabs corresponding to a neatly typewritten index. The binder cover and edge shall clearly identify the Contractor’s name, name of the project, date and submittal number.
- E. Important Notice:
1. **After material or equipment has been submitted and approved, no substitutions will be allowed. Any equipment installed that is different than the approved shop drawings and submittals will be removed and replaced at the Contractor’s expense without exception!**
 2. If Contractor's submittal(s) depart from the Contract Documents, the Contractor shall make specific mention thereof in his letter(s) of transmittal, otherwise review of such submittals by the Engineer shall not constitute review of such departure(s).
 3. The Contractor may be charged for costs incurred by the Engineer for third and subsequent submittal reviews. Cost for Engineer’s review time shall be billed at the Engineer’s standard hourly rates.
- F. For control panels, motor starters and other equipment requiring multiple terminations of components and devices, the Contractor shall submit detailed shop drawings consisting of point-to-point wiring diagrams, bill of materials, interior and exterior elevations with dimensions prepared by the equipment manufacturer or a UL 508A recognized system integrator.

1.03 RECORD DRAWINGS AND OPERATION AND MAINTENANCE MANUALS

- A. Record Drawings: On completion of work, Contractor shall furnish a complete set of Record Drawings and Shop Drawings which properly reflect final locations and sizes of conduit, equipment fixtures, controls, etc., as actually installed. Dimensions shall be included on the Contractor's as-built Drawings showing exact location of underground conduits.
- B. Operation and Maintenance (O&M) Manuals: Contractor shall provide O&M manuals for the standby generators and automatic transfer switches furnished under this contract. O&M manuals must be submitted and approved before final inspection of the project so that they may be used during startup. Soft copies shall be in "pdf" format with "character recognition" and shall include the following as a minimum:
 - 1. A cover sheet to identify the Contractor's name, name of the project, date and description, i.e. "Electrical Equipment O&M Manual".
 - 2. Bookmarks within each section for each major component within.
 - 3. Complete manufacturer name and model number of each item.
 - 4. Descriptive data, wiring diagrams, dimensional drawings, etc from the approved submittals/shop drawings.
 - 5. Complete instructions regarding the installation, operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
 - 6. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or components not related to equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
 - 7. Copy of warranties issued on the installation, showing dates of expiration.
- C. Hard copies, if provided, shall be bound in 3-ring binders (2" max) and include all information as described above for soft copies. The binders shall include tabs corresponding to a neatly typewritten index. The binder cover and edge shall clearly identify the Contractor's name, name of the project, date and identified as "Electrical Equipment O&M Manual".

1.04 QUALITY ASSURANCE

- A. The Contractor performing the electrical construction and installation shall be a reputable Contractor licensed in the State of Arizona to do electrical **commercial** construction. As a minimum, an "L-11 Commercial" license is required. If any electrical work over 600V is required, the Contractor must also be licensed to work on High Voltage Electrical and Transmission Lines.
- B. The Contractor must be located within a 400-mile radius of the project and have been in that vicinity for a minimum of five (5) years.

- C. The Contractor must have a minimum of five (5) years experience as a Contractor installing electrical systems for other water and wastewater projects of similar type, size and requirements. If requested, the Contractor must submit documentation and list of references of recent projects similar to this one.
- D. All equipment furnished shall be new and of current design. Like equipment shall be of the same manufacturer.
- E. Unless otherwise indicated, all equipment and components shall be rated for use in the environment installed. Outdoor equipment shall be weatherproof or rated for outdoor use.

1.05 SPACE REQUIREMENTS

- A. Space Requirements: In the preparation of Drawings, a reasonable effort has been made to include equipment manufacturer's recommendations. Since space requirements and equipment arrangement vary according to manufacturer, the responsibility for initial access and proper fit rests with the Contractor. Final arrangement of equipment and service connections shall allow the unit to be serviced, including space to pull motors, change fuses, and operate switches. Minimum working clearances shall be as required by NEC and local codes.

1.06 COORDINATION

- A. Contractor shall coordinate with all other trades to avoid conflicts and interferences. No extra compensation will be allowed for changes made necessary due to interference between work of various trades.
- B. Any discrepancies noted in these contract documents or discrepancies between Drawings and actual field conditions shall be promptly brought to the Engineer for a decision. No extra compensation will be allowed for changes made by the Contractor without Engineer's consent.
- C. Carefully check and coordinate each device location and elevation. Also check routing of all conduits for conflicts with structures, mechanical piping, ducts, etc. to avoid conflicts.

1.07 REGULATORY REQUIREMENTS

- A. Electrical work, including connection to electrical equipment integral with mechanical equipment, shall be performed in accordance with the latest published regulations of the National Electrical Code (NEC), State and local codes, and according to the latest Institute of Electrical and Electronic Engineers (IEEE); American National Standards Institute (ANSI); American Society for Testing and Materials (ASTM); Insulated Cable Engineers Association (ICEA); National Electrical Manufacturers Association (NEMA) Standards; and the latest published regulations of the Federal Occupational Safety and Health Act (OSHA). When applicable, the material used in the performance of the electrical work shall be listed by the Underwriters' Laboratories, Inc. (UL) for the class of service for which they are intended.

- B. Control panels shall be assembled and wired by a UL 508A recognized panel shop. All control panel components shall be UL recognized or ground fault protected per UL 508A fabrication standards. Each control panel assembly shall be fabricated according to UL 508A Standards and shall bear a serialized UL 508A label.

1.08 WARRANTY

- A. In addition to specific warranties required by the Specifications, the Contractor shall leave the entire installation in complete working order and free from defects in materials, workmanship or finish. Contractor shall repair or replace at his own expense any part that may develop defects due to faulty material or workmanship during the tests and within a period of one year after the work is accepted by the Engineer and Owner. Contractor shall repair or replace existing equipment and work that is damaged during the repair of defective apparatus, materials or workmanship.
- B. All manufacturer's warranties shall be filled out in their entirety by the Contractor for the Owner using the Owner's name and address. Unless otherwise specified, equipment warranty periods will commence on date of final acceptance.

1.09 DRAWINGS

- A. **Clarity and Legibility:** For purposes of clarity and legibility, the Drawings are diagrammatic only. Drawings are not intended to show every fitting, junction, gasket or component necessary, nor every difficulty that may be encountered during installation. Conduit routing may be adjusted in the field. Size and location of equipment are drawn to scale wherever possible. Contractor shall refer to related data in all Contract Documents and shall verify this information on site.
- B. Schematic diagrams are provided to indicate the control strategy intent only. Final circuitry shall be as determined by the Contractor or his vendors. Actual wiring diagrams shall be provided by the Contractor and reviewed by the Engineer for a fully functional system as intended.

1.10 REFERENCES

- A. The specifications reference known standards and codes. Each such standard referred to shall be considered a part of the Specifications to the same extent as if reproduced therein in full. The following is a representative list of such Associations, Institutes and Societies, together with the acronym by which each is identified.

AASHTO	American Assoc of State Highway and Transportation Officials
AIEE	American Institute of Electrical Engineers
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IES	Illumination Engineering Society

NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NETA	National Electrical Testing Association
NFPA	National Fire Protection Association
NTUA	Navajo Tribal Utility Authority
UL	Underwriter's Laboratories, Inc.

- B. Every reference in the Specifications shall mean the latest printed edition of each in effect at the Contract Date.

1.11 UTILITY SERVICE

- A. Contractor shall contact NTUA to provide or remove electrical service(s) to the site. This includes the permanent as well as any temporary service requirements. The Contractor shall provide all necessary labor and material required to obtain this service(s) in accordance with utility requirements. Any utility company fees and charges associated with providing, maintaining and usage of these services shall be paid by Owner.
- B. Submit copies of electrical service entrance equipment to NTUA for approval prior to releasing switchgear for fabrication. A copy of this approval letter shall be submitted to the Engineer.

1.12 ABBREVIATIONS

- A. References on the Drawings to various abbreviations have been made. The following is a representative list of such abbreviations together with the acronym by which each is identified.

AFF	Above finished floor
AFG	Above finished grade
AI	Analog input
AO	Analog output
ATS	Automatic transfer switch
C	Conduit
C/B	Circuit Breaker
CKT	Circuit
CPT	Control power transformer
Cu	Copper
DI	Digital input
DIST	Distribution
DO	Digital output
DWG	Drawing
GND	Ground
GFCI	Ground Fault Circuit Interrupter
GFI/GFP	Ground Fault Indication/Protection
GRS	Galvanized Rigid Steel Conduit
HPS	High Pressure Sodium
IMC	Intermediate Metal Conduit
INST	Instrument

LED	Light Emitting Diode
MBJ	Main bonding jumper
MCB	Main Circuit breaker
MCC	Motor Control Center
MCP	Motor Circuit Protector
MFR	Manufacturer
MLO	Main Lug Only
NC	Normally Closed
NO	Normally Open
NTUA	Navajo Tribal Utility Authority
PC	Personal computer
PLC	Programmable logic controller
PR	Pair
REQ'TS	Requirements
RTU	Remote terminal unit
SES	Service entrance section
SPD	Surge Protective Device
RMC	Rigid Metal Conduit (GRS or IMC)
RVSS	Reduced Voltage Soft Starter
SWBD	Switchboard
TSP	Twisted Shielded Pair
TST	Twisted Shielded Triad
VFD	Variable frequency drive
WP	Weatherproof

****END OF SECTION****

SECTION 16110

RACEWAYS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Metallic and non-metallic wiring raceways.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data demonstrating compliance with this specification including couplings, fittings, bushings, and hangers.
- B. Submit on the proposed method for separating conduits in underground ductbanks.

1.03 QUALITY ASSURANCE

- A. Perform work in accordance with NECA Standard of Installation and NFPA 70.

1.04 RELATED WORK

- A. Specification Section 16195, Electrical Identification

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Conduit:
 - 1. Rigid metal, intermediate and EMT:
 - a. Allied
 - b. Republic
 - c. Triangle Conduit and Cable Co.
 - d. Wheatland
 - 2. PVC coated rigid steel:
 - a. Ocal
 - b. Robroy
 - c. Calbond
 - d. Gafco Green
 - 3. Flexible and flexible water-tight:
 - a. Alflex Corp.
 - b. Carlon Products Corp.
 - c. Carol Cable Co., Inc.
 - d. Electri-Flex
 - e. Sealtite
 - 4. Non-metallic PVC:
 - a. Can-Tex

- b. Carlon
- c. PW Eagle/JM Eagle
- 5. Conduit supports and hangers:
 - a. Caddy
 - b. Thomas and Betts
 - c. Appleton
 - d. Crouse-Hinds
 - e. B-Line Systems
- 6. Supporting Channel:
 - a. G-Strut
 - b. Unistrut
 - c. B-Line

2.02 MATERIALS

- A. Metallic Conduit:
 - 1. Rigid steel:
 - a. Hot dipped galvanized rigid steel; meet ANSI C80.1 and ASTM A153; UL labeled and meet UL Standard No. 6.
 - b. All fittings shall be threaded. Threadless couplings shall not be used unless specifically approved by the Engineer.
 - c. All conduit body covers shall be secured with machine screws threaded onto the conduit body. Covers secured by snaptight or wedge-nuts are unacceptable.
 - d. Where PVC coated rigid steel conduit is indicated on the Drawings, the conduit shall be galvanized steel with a factory installed PVC coating. All conduit fitting, boxes, connectors, etc. shall also be PVC coated by the factory.
 - e. No aluminum conduit shall be permitted unless approved by the Engineer.
 - 2. Intermediate: Shall be same as rigid above with thinner wall.
 - 3. Electrical metallic tubing (EMT or Thin-wall) shall be:
 - a. Galvanized; meet ANSI C80.3; UL labeled; marked with manufacturer's name.
 - b. Thin-wall conduit fittings for damp or wet locations shall be of the regular watertight design, with hexagonal nuts and center portions requiring the use of a wrench during installation.
 - c. Setscrew type fittings are not permitted under any circumstances.
 - 4. Flexible conduit:
 - a. UL-listed flexible rubber or plastic coated metallic type with watertight ferrule and sleeve type connectors. Standard steel type flexible conduit is unacceptable.

- b. ANSI/NEMA FB1 steel connectors. Connectors must be PVC coated where installed in corrosive environments or where PVC conduit or PVC coated GRS conduit is specified.
 - c. Flexible conduit installed in hazardous classified areas shall be explosion-proof or be rated for use in the specified area classification.
- B. Non-Metallic PVC Conduit:
- 1. Rigid non-metallic conduit Polyvinyl Chloride (PVC) type II PVC shall be schedule 40, suitable for use with 90 degree rated wire. Conduit shall bear UL labels for above and below ground use.
 - 2. All PVC conduit 1-1/4 inch and larger with bends greater than 45° shall utilize factory bends.
 - 3. Where the enclosure or raceway is subject to physical damage, conductors shall be installed in rigid metal conduit, intermediate metal conduit, Schedule 80 rigid nonmetallic conduit or equivalent.
 - 4. Meet UL standard #651.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. General:
- 1. Raceways shall be concealed, where possible, unless otherwise indicated on the Drawings. When exposed, confirm the exact routing with the Engineer prior to roughing in.
 - 2. Sizing: Minimum conduit sizes are indicated on the Drawings. The Contractor may choose to install larger conduit for ease of installation or wiring pulling at no additional cost to the Owner. If conduit or raceway size is not indicated on the Drawings, raceways shall be sized per NEC. Unless otherwise indicated, minimum conduit size shall be 3/4 - inches.
 - 3. Unless otherwise indicated, all exposed conduits shall be galvanized steel rigid metal conduit (RMC) or intermediate metal conduit (IMC). All direct buried or concrete encased conduits to be Schedule 40 PVC.
- B. Conduit:
- 1. Conduit shall: Have openings temporarily plugged, using “pennies” or equal, to exclude plaster or other foreign materials; be reamed after cutting; have joints cut square, and butt solidly into fittings; have the ends terminated in a proper bushed fitting, be rigidly supported so as to prevent undue stress or strain on the couplings and connectors; be swabbed before conductors are pulled in.
 - 2. Concealed conduits shall be run in a direct line with long sweep bends and offsets. Horizontal runs shall be run with a slight incline, to prevent low spots or pockets (for drainage).

3. Conduits shall be continuous from outlet to outlet, from outlets to cabinets, pull or junction boxes and shall be secured to boxes with lock nuts and bushings in such a manner that each system shall be electrically continuous throughout. "Erickson" couplings shall be used where required. No running threads shall be cut.
4. Install conduit systems completely before conductors are pulled. Conduits shall be securely supported at proper intervals to structures with steel clamps, or conduit hangers or by special supporting assemblies when indicated on the Drawings.
5. Conduit terminations shall contain insulated bushings. Provide grounding type bushings where steel conduit is stubbed into nonmetallic enclosures, stubbed up in the base of freestanding enclosures or where locknuts cannot assure proper ground continuity between metallic enclosures and the steel conduit. Provide service entrance and transformer connection conduits with grounding type bushings.
6. Exposed conduits shall be installed parallel to walls, floor and ceilings or at right angles to the building lines. Exposed bends shall be used only where approved. Covers shall be secured to bodies with machine screws.
7. Electrical metallic tubing (EMT) or "Thin-wall" may not be used except where specifically indicated on the Drawings or as directed by the Engineer.
8. Hickey bends shall not be used for 1-inch and larger conduits. Either manufactured elbows or bends fabricated in a bending machine shall be used. The radius of the inner edge of bends shall be six times the internal diameter of the conduit for conduit sizes up to 2 ½-inches and 12 times internal diameter for 3-inches conduits and larger. A run of conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than 360° of total bends.
9. Conduit shall not be run above or below water piping, and must be individually supported.
10. In wet locations, and in locations where walls are frequently washed, the entire conduit system, including boxes and fittings used, shall be installed and equipped to prevent water from entering conduit. Conduit shall be so mounted so that there is at least ¼-inch air space between conduit and wall or similar supporting surface.
11. Schedule 40 PVC conduit may be used for buried conduit installations as permitted by the NEC and local codes except where galvanized rigid steel is specified. Couplings, transition fittings, adhesives, primer and installation procedures recommended by the conduit manufacturer and all applicable codes must be strictly followed.
12. Install liquid-tight flexible metal conduit at motors, transformers and equipment which are subject to vibration or require movement for maintenance purposes. Provide necessary reducer where equipment

furnished cannot accept 3/4-inch size flexible conduit. Limit flexible conduit length to 3-foot maximum.

- C. Sleeves, Inserts, etc.: Lay out and install work in advance of the laying or pouring of floors and erection of walls. Furnish and install sleeves that may be required for openings through floors, wall, etc. Where plans call for conduit to be run exposed, furnish and install inserts and clamps for the supporting of conduit. If this Contractor does not properly install sleeves and inserts required, he will be required to do the necessary cutting and patching later, at his own expense, to the satisfaction of the Engineer.
- D. Installation of Underground Conduits:
1. Install underground conduit as indicated on the Drawings. Backfill material around the conduits must be clean-fill (dirt with rocks no larger than 1/2-inch).
 2. Conduit bends shall have long sweep radius curves instead of standard elbows where indicated on the Drawings. All PVC conduit bends greater than 45° shall be factory-made for conduits larger than 1-inch.
 3. All underground PVC conduit shall be buried a minimum of 24-inches below finished grade, except when located below a concrete slab or freestanding electrical equipment. Conduit shall be installed deeper than 24-inches wherever required to avoid existing piping, tunnels, or other obstructions.
 4. Underground conduits in ductbanks shall be separated and supported with pre-manufactured plastic chairs, unless submitted and approved otherwise, installed at 5-foot intervals in the trench.
 5. ***After duct is in place, notify the Engineer prior to backfill for inspection.*** Failure to do so will result in removal of all backfill material to expose the conduits for inspection.
 6. During backfill, provide plastic warning tape at 12-inches below finished grade over underground electrical installations which reads, "Caution - Buried Electrical Line Below".
 7. Any portion of the conduit with less than 24-inches of cover shall be PVC coated rigid metal conduit or galvanized rigid metal conduit wrapped with 20-mil rubber tape half-lapped to a thickness of 40-mils. PVC conduits are permitted to be stubbed up directly into freestanding electrical enclosures.
 8. Where terminating PVC conduit in a freestanding enclosure, underground junction box, manhole/handhole or other similar locations, provide each termination with a bell end.
 9. Rigid metal conduit terminations shall contain insulated bushings. Provide grounding type bushings where steel conduit is stubbed into nonmetallic enclosures, stubbed up in the base of freestanding enclosures or where locknuts cannot assure proper ground continuity between metallic enclosures and the steel conduit. Install grounding type bushings on all service entrance and utility transformer connection conduits.

10. Spare conduits shall be capped with an approved plug.
11. Before pulling cables into underground conduits, pull a mandrel ¼-inch smaller than the conduit inside diameter and pulled through each conduit, and if any concrete or obstructions are found, the Contractor shall remove them and clear the conduits. Underground conduits shall be swabbed before cables are pulled in.
12. After duct runs are completed and set, backfill the trenches and tamp thoroughly to 90 percent compaction.

3.02 CONDUIT MARKERS

- A. All conduits with conduit designations indicated on the Drawings shall be identified at each termination. See Section 16195 - Electrical Identification for conduit tag requirements.

****END OF SECTION****

SECTION 16120
WIRES AND CABLES
(600V OR LESS)

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Cables and wires rated 600 volts or less, as specified, including wiring of all devices.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data on all power, signal and communication cables demonstrating compliance with this Specification.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards:
 - 1. NFPA 70 (NEC)
 - 2. UL listing for materials.
 - 3. ICEA S-66-524
 - 4. NEMA WC-7
 - 5. ASTM B-3 or B-8

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Cable:
 - 1. General Cable
 - 2. Okonite
 - 3. Southwire
 - 4. Encore
- B. Connectors:
 - 1. Ideal
 - 2. Burndy Corp.
 - 3. Thomas and Betts Co.
 - 4. O.Z. Gedney
 - 5. Minnesota Mining & Manufacturing (3M)

2.02 MATERIALS

- A. Conductors for wire and cable shall be stranded copper with 98 percent conductivity and shall be tinned or untinned in accordance with established standards for the type of insulation around the conductors. Solid conductors are not acceptable.

- B. Wire and cable shall be stamped approximately every two feet to indicate voltage, type, temperature rating, and other significant data or warnings.
- C. Conductors for general purpose wiring shall meet the following requirements:
 - 1. Power: Type XHHW-2. Minimum conductor size for power shall be No.12 AWG.
 - 2. Control: Type XHHW-2 for conductors run in conduit, minimum size No.14 AWG. Type MTW for conductors contained in control panels, minimum size No.14 AWG or No.16 AWG when protected by an overcurrent device of 10A or less.
- D. Wire Pulling Lubricant: Lubricant shall be UL listed and be of a consistency that will not leave an obstruction or tackiness that prevents pulling out wires in the future. No soap flakes or vegetable soaps will be permitted. Lubricant in shall be Ideal Wire Lube or equal.
- E. Cable Ties: Wiring in panels, cabinets, etc. shall be neat and tied with “Ty-Rap” T&B “TY-5418” series, or Panduit Co. “Cable Wrap”. Cable ties used in outdoor locations shall be UV stabilized.
- F. Terminations:
 - 1. 3-M Scotchlok lugs and connectors - copper.
 - 2. O-Z solderless connectors, grounding devices, power connectors, armored cable fittings, and cable terminations.
 - 3. Burndy - copper - all types as appropriate for cable size and configuration.
- G. Connector material shall be compatible with conductor material to prevent corroding, differences in coefficients of expansion or electrolysis.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Install wires and cables in NEC approved raceways (Section 16110). All wire and cable must be installed in a raceway, unless otherwise indicated on the Drawings.
- B. Branch circuit and feeder conductors shall have insulation with the following color. Phase tape is unacceptable.
 - 1. Grounding conductor-Green.
 - 2. Neutral - White.
 - 3. 120/240V Phase A - Black.
 - 4. 120/240V Phase B - Red.
 - 5. 120/208V Phase A - Black.
 - 6. 120/208V Phase B - Red.
 - 7. 120/208V Phase C - Blue.
 - 8. 277/480V Phase A - Brown.
 - 9. 277/480V Phase B - Orange.
 - 10. 277/480V Phase C - Yellow.

- C. 6-inch minimum loops shall be provided at each outlet, device or luminaire. Unused wires in outlet boxes, shall be rolled up, connected together and taped or capped with wire nuts. Mark bundled, unused spare wires as “SPARE FROM [origination]”.
- D. Branch circuit sizing: Where wire size is not indicated on the Drawings, NEC and local codes shall govern. However, minimum branch circuit conductor size shall be No. 12 AWG.
- E. Pulling Cables: Wires and cables shall be carefully handled during installation. Lubricant used for pulling in wires and cables shall be used. Use a dynamometer when pulling conductors by mechanical means.
- F. Bending radius: Do not exceed the manufacturer’s maximum bending radius.

3.02 SPLICES AND TERMINATIONS

- A. Splices:
 - 1. Splices in conductors shall not be used unless otherwise indicated on the Drawings or approved by the Engineer.
 - 2. Where splices are allowed or necessary, they shall be mechanically strong and well made so that the electrical resistance of a joint shall not exceed that of 2-feet of the conductor.
 - 3. Splices shall be made only in junction boxes and never in conduit.
 - 4. Above Grade Splices:
 - a. Utilize wing nut solderless connectors for splicing No. 8 AWG and smaller conductors. Follow manufacturer’s recommendations for sizing, stripping, twisting, etc.
 - b. Utilize insulated butt connectors crimped end-to-end for splicing No. 6 AWG and larger conductors. Follow manufacturer’s recommendations for sizing, stripping and crimping.
 - 5. Below Grade Splices:
 - a. Utilize waterproof splice kits or wing nut solderless connectors with cast-resin waterproofing for splicing No. 8 AWG and smaller conductors. Follow manufacturer’s recommendations for sizing, stripping, twisting, etc.
 - b. Utilize insulated butt connectors crimped end-to-end with cast-resin waterproofing for splicing No. 6 AWG and larger conductors. Follow manufacturer’s recommendations for sizing, stripping and crimping.
 - c. Utilize insulated butt connectors crimped end-to-end for all below grade splices or No. 6 AWG and larger conductor splices above grade. Follow manufacturer’s recommendations for sizing, stripping and crimping.
- B. Motor terminations: Ring type, crimped connectors shall be installed on all conductors and bolted together back-to-back. For terminations with No.6 and smaller wire, use 10-24 bolts. Use bolts that match the connector bolthole size for

all other motor terminations. Apply one layer of cambric tape followed by three layers of rubber tape and finally, top with one layer of black vinyl tape.

- C. Non-motor terminations: Use ring or fork type, crimped connectors for all screw-on terminations. Wrapping wire around a binding post is unacceptable.
- D. Where special tools are required to properly install the particular connector the special tools must be used.

3.03 WIRE MARKERS

- A. All conductors shall be labeled at each termination and splice. See Section 16195 - Electrical Identification for wire marker requirements.

****END OF SECTION****

SECTION 16130

BOXES

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Outlet boxes, pull and junction boxes and underground junction boxes.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data for standard outlet boxes up to six gang, including floor type demonstrating compliance with specification requirements and Drawings.
- B. Shop Drawings: Submit drawings for special pull, outlet, and junction boxes demonstrating compliance with NEC and specification requirements. Drawings shall indicate box dimensions and locations in building.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards:
 - 1. NEMA 250
 - 2. NFPA 70
 - 3. UL listing for materials.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Appleton Electric
- B. Crouse-Hinds
- C. Killark
- D. Raco
- E. Hoffman Engineering Co.
- F. O.Z. Gedney Co.
- G. Steel City
- H. Hubbell
- I. Rittal

2.02 MATERIALS

- A. Outlet boxes for concealed conduits and flush-mounted wiring devices shall meet the following requirements:

1. Stamped, one piece, galvanized steel.
 2. Proper size and shape for conduits entering them.
 3. UL listed for their application.
 4. ANSI/NEMA OS-1 for galvanized steel; ANSI/NEMA OS-2 for non-metallic.
- B. Outlet boxes for exposed conduit systems and exterior locations shall be of the threaded-hub, cast-metal, conduit type fitting suitable for the wiring devices to be installed. Covers (blank, switch, receptacle, etc.) shall be the type specifically designed to fit the specified boxes.
- C. Above grade electrical junction and pull boxes shall be sheet metal with an ANSI 61 gray color with size and type as indicated on the Drawings. NEMA rating shall be as indicated on the Drawings. Where a NEMA rating is not indicated, outdoor boxes shall be NEMA 3R and indoor boxes shall be NEMA 12. Box sizes shall be as indicated on the Drawings. Where sizes are not indicated or larger size is required to meet code, the box size shall be increased as required by the National Electrical Code.
- D. Wireways:
1. Wireways shall be sized as indicated on the Drawings or as required by the National Electrical Code. Where sizes are not indicated or larger size is required to meet code, the wireway shall be sized such that the cross-sectional area of the wireway at any one point does not exceed 40% per the National Electrical Code.
 2. Cover: Hinged with removable latches where feasible.
 3. UL listed for steel enclosed wireway or auxiliary gutter.
 4. Furnished complete with covers, elbows, tees, junction boxes, end covers, connectors and hangers.
 5. Unless otherwise indicated, wireways shall be NEMA 3R.
 6. Wireways in outdoor locations shall be fully gasketed.
- E. Underground junction boxes:
1. Construction: Electric underground junction boxes shall be precast concrete and size as indicated on the Drawings. Underground junction boxes shall have precast concrete extensions.
 2. Covers: Covers shall be rectangular, reinforced concrete and have the text "ELECTRIC" cast into the cover.
 3. Approved Manufacturer: Christy, or equal.
- F. Fittings, hangers, fastenings, etc., shall be of material that will prevent chemical reaction between itself and conduit or device it is fastening or supporting.

PART 3 -- EXECUTION

3.01 BOX LOCATIONS

- A. Location of Boxes: In order that boxes may be placed in proper locations, the Contractor shall familiarize himself with the details of these spaces and carefully lay out boxes so that the equipment or piping of other trades passing under, over, across or in close proximity to same, will not cause these boxes to be inaccessible for use or maintenance. Contractor shall consult with other Contractors and trades on the project and obtain details of the project to locate outlet boxes properly.
- B. Contractor shall be responsible for the exact and proper location of the various portions of his work. Consult the Drawing and details.
- C. Mounting Heights: The exact mounting height of each switch, receptacle, light fixture outlet, etc., shall be confirmed on the premises in conference with the Engineer. Unless otherwise indicated, receptacles to be mounted at 18-inches and light switches to be mounted at 42-inches above finished floor/grade.

3.02 INSTALLATION

- A. No thru-boxes shall be permitted.
- B. Boxes shall meet the following requirements:
 - 1. Proper size and shape for conduits entering them.
 - 2. Installed so that device and/or cover plates shall be tight and plumb with wall finish.
 - 3. Have unused openings closed with knock-out closures.
 - 4. Securely fastened to building or structure.
- C. Surface-mounted outlet boxes shall meet the following requirements:
 - 1. Outdoor boxes shall be cast steel or cast aluminum with threaded hubs.
 - a. Fastened with not less than two Paine, Phillips, Ackermann-Johnson, or equivalent, screw anchors and round head machine screws on brick and concrete walls or ceilings.
 - b. Under no circumstances will drilling of cast boxes be allowed.
 - c. PVC coated boxes shall be used for installations with PVC coated rigid steel conduit.
 - d. Be provided with a vapor-proof gasket in wet locations or where indicated as "WP" (weatherproof) on the Drawings.
 - e. Install a weatherproof-while-in-use cover on all outdoor receptacles.
 - 2. Bell boxes may be used for indoor applications where rigid steel or IMC conduit is required.
- D. Flush-mounted outlet boxes shall:
 - 1. Be solid ganged boxes for more than two devices.
 - 2. Contain a plaster ring to bring the wiring device attachment points within ¼-inch of the finished wall surface.
 - 3. Be installed so that device covers are tight and plumb with wall finish.

4. Be installed as close as possible to the lock side of door trim for light switches.
- E. Bracket outlets shall be level and centered on columns or above doors when installed in these locations.
- F. Pull boxes and junction boxes shall be:
1. Installed where indicated on the Drawings or where necessary to not exceed 360 degrees of conduit bends.
 2. Entirely accessible.
 3. Securely mounted to building structure independent of the conduits connected to them.

****END OF SECTION****

SECTION 16140
WIRING DEVICES

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Wiring devices such as but not necessarily limited to power receptacles and light switches.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data for each wiring device including device covers demonstrating compliance with these Specifications and UL labeling.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and standards:
 - 1. NEMA
 - 2. UL listing
 - 3. NFPA 70

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Hubbell
- B. Leviton
- C. Bryant
- D. Crouse-Hinds
- E. Pass & Seymour

2.02 MATERIALS

- A. Light switches and receptacles shall meet NEMA WD1 and WD6 standards, be UL listed and be Heavy Duty, **Industrial** Specification grade. Commercial specification grade wiring devices are not acceptable.
- B. Amperage rating of each wiring device shall match the circuit's overcurrent device amperage rating to which it is connected.
- C. Wiring devices shall have an ivory finish unless otherwise specified.
- D. Power receptacles shall be the grounded type. Furnish ground fault circuit interrupter (GFCI) type where indicated on the Drawings or as required by the NEC.
- E. All GFCI receptacles shall be listed weather-resistance (WR) type receptacles.
- F. Light switches shall be the quiet type.

- G. Wiring Device Coverplates:
1. Unless otherwise indicated, coverplates installed indoors or in control panels shall be brushed anodized aluminum.
 2. Weatherproof locations: Wiring devices installed outdoors or where identified on Drawings with “WP” shall contain a gasketed coverplate UL approved for wet locations.
 3. Where weatherproof-while-in-use coverplates are indicated on the Drawings or required by NEC, power receptacles shall be provided with a cover that is listed for “extra duty” and maintains UL approval for wet locations when a cord is plugged into the receptacle.

PART 3 -- EXECUTION

3.01 INSTALLATION/APPLICATION

- A. Devices and coverplates shall be plumb and parallel to adjacent surfaces or trim. Flush-mounted devices must be flush with finished wall surfaces and the coverplates must be tight to surfaces over which they are installed.
- B. Receptacles identified as GFCI or when required by the NEC shall have individual GFCI receptacles installed for each outlet. Installing a single GFCI receptacle and standard receptacles connected to the load side of the single GFCI receptacle is unacceptable.

3.02 FIELD QUALITY CONTROL

- A. Contractor shall verify that the openings have been properly patched around devices without damage to devices.
- B. Damaged or painted devices shall be replaced or cleaned as directed by the Engineer.

****END OF SECTION****

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 -- GENERAL

1.01 SECTION INCLUDES

- A. Nameplates and labels
- B. Wire and cable markers
- C. Conduit markers

1.02 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code.
 - 1. NEC 110-22 Identification of Disconnecting Means
 - 2. NEC 200-6 Means of Identifying Grounded Conductors
 - 3. NEC 200-10 Identification of Terminals
 - 4. NEC 210-5 Identification for Branch Circuits
 - 5. NEC 215-8 Means of Identifying Conductor with the Higher Voltage to Ground
 - 6. NEC 230-70, (B) Service Equipment, Marking
 - 7. NEC 310-11 Marking
 - 8. NEC 310-12 Conductor Identification
 - 9. NEC 400-22 Grounded-Conductor Identification
 - 10. NEC 400-23 Equipment Grounding Conductor Identification
 - 11. NEC 408-13 Panelboard circuit identification
- B. UL standard 224- Standard for Extruded Thermoplastic Insulating Tubing.

1.03 SUBMITTALS

- A. Product Data: Provide catalog data for the following:
 - 1. Wire and cable marking system
 - 2. Nameplate materials and fasteners
 - 3. Conduit markers

1.04 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

PART 2 -- PRODUCTS

2.01 NAMEPLATES AND LABELS

- A. Engraved laminated plastic nameplates with black letters on white background shall be installed on the following as a minimum:
 - 1. Electrical distribution equipment enclosures
 - 2. Disconnect switches and motor controllers
 - 3. Control panels and cabinets
 - 4. Each motor controller or control panel door mounted device
 - 5. Major components, control relays and terminal block strips mounted on the backpanel of control panels
- B. Letter Size:
 - 1. Use 3/8-inch letters for identifying electrical distribution equipment enclosures and other large control panels and cabinets. Use 3/16-inch letters for identifying individual control panel components (inside or out) and small control panels/enclosures.

2.02 WIRE MARKERS

- A. Manufacturer: Raychem Corporation Model ShrinkMark or equal.
- B. Description: heat shrinkable radiation cross-linked, thermally stabilized, modified polyolefin sleeves with 3:1 shrink ratio. Markers shall be UL Standard 224 recognized.
- C. Sleeves shall be smear resistant prior to shrinking and achieve mark permanency when shrunk without the need for permatizing equipment. Sleeves should achieve mark permanency when standard ballpoint pens or high-carbon content fabric ribbons are used. The markers shall be flattened and mounted on a carrier suitable for use with commercially available print equipment. Markers shall be printable on both sides. Markers shall be resistant to common industrial fluids including Freon TF, Isopropyl alcohol, and Ethylene Glycol.
- D. Locations: Each conductor at each termination and splice.
- E. Legend:
 - 1. Power and Lighting Circuits: Branch circuit or feeder number indicated on the Drawings.
 - 2. Control Circuits: Control wire number indicated on approved schematics, interconnection diagrams and shop drawings.
 - 3. Wire numbers shall be the same at both ends of the wire.

2.03 CONDUIT MARKERS

- A. Furnish and install conduit markers on ends of each conduit run and in intermediate locations such as manholes and handholes. Conduit markers shall be 19 gauge, 1 1/2-inch diameter round brass with backfilled legend, Style #250-BL as manufactured by Seton Nameplate Corporation or equal. Marker shall identify conduit as indicated on the Drawings. If a conduit is not identified on the Drawings, the Contractor shall consult the Engineer for the proper identification.

PART 3 -- EXECUTION

3.01 NAMEPLATES

- A. Install nameplates parallel to equipment lines.
- B. Secure nameplates to the exterior of electrical equipment using UL-508A approved die and tapped stainless steel screws (APM SEELSKREW or equal).
- C. Secure nameplate to inside surface or backpanels of control panels with a permanent adhesive (Liquid Nails or equal).

3.02 WIRE MARKERS

- A. Wire markers shall be a minimum of 3/8-inches in length and placed as near as possible to the end of the wire. Orient wire marker such that the writing can be read without turning or twisting the wire.
- B. Wire numbers shall be the same at both ends of the wire.

3.03 CONDUIT MARKERS

- A. Attach markers near the end of exposed conduits with stainless steel tie-wire.
- B. Secure conduit markers to the floor using a permanent epoxy where conduits terminate in bell ends flush with finished floor in freestanding equipment.

****END OF SECTION****

SECTION 16250

DIESEL ENGINE GENERATORS

PART 1 -- GENERAL

1.01 DESCRIPTION:

- A. Section includes furnishing and installing a UL Listed, enclosed outdoor diesel engine-driven standby generators complete with all appurtenances, as indicated on the Drawings and specified herein. The standby generator supplier must be the authorized distributor for the manufacturer of the engine.

1.02 REFERENCE:

A. STANDARDS:

1. National Electrical Manufacturers Association (NEMA):
 - a. AB-1, Molded Case Circuit Breakers.
 - b. ICS, General Standards for Industrial Control and Systems.
 - c. MG-1 1978, Motors and Generators.
 - d. SG3, Low Voltage Power Circuit Breakers.
2. Institute of Electrical & Electronic Engineers (IEEE).
3. Underwriters' Laboratories, Inc. (UL-2200).
4. Diesel Engine Manufacturers Association.
5. National Fire Protection Association (NFPA):
 - a. NFPA-110, Standard for Emergency and Standby Power Systems.
6. American National Standards Institute (ANSI):
 - a. 50.5 Rotating Exciters for Synchronous Machines.
 - b. C50.12 Salient Pole Synchronous Generators and Condensers.
7. Environmental Protection Agency (EPA) 70 FR 39870

1.03 SUBMITTALS:

A. Submit the following:

1. Manufacturer's specifications, catalog data, descriptive matter, illustrations, diagrams, etc., including but not limited to engine, generator, voltage regulator, fuel tank, batteries, battery charger, exhaust system, water jacket heater, output circuit breaker and generator control panel showing compliance with this Specification Section.
2. Drawings: Outline drawing of each generator set with overall dimensions. Interconnection wiring diagrams of the generator control systems showing control connections between generator, transfer switch and auxiliary equipment. Power and control wiring conduit entrance locations. Fuel lines and connections. Base anchoring footprint drawing. Control panel layout.

3. A certificate acknowledging that the generator set will properly start and run the loads indicated on the Drawings for 16 continuous hours with the installation configuration within the CMU block walls as indicated on the Drawings.
 4. Engine generator unit prototype test report of identical size, type and construction. Generator test report shall certify the following:
 - a. Maximum output power
 - b. Maximum motor horsepower starting capacity
 - c. Fuel consumption at full load
 - d. Engine/alternator cooling air flow (heat rejection)
 - e. Transient response and steady state governing
 - f. Alternator temperature rise
 - g. Single step load pickup
 - h. Harmonic analysis indicating THD for voltage and current
 - i. Short circuit test indicating maximum current withstand
 - j. Torsional analysis
 - k. Sound level (dB) at 23 feet from unit.
- B. Factory tests on the engine generator set shall be conducted, certified, documented and submitted to the Engineer for review prior to shipment. The test shall be conducted at rated load and 0.8 power factor in accordance with NFPA Factory Test Reports. Tests shall include the following:
1. Steady-state voltage and frequency analysis
 2. Transient response
 3. Maximum power output
 4. Fuel consumption
 5. Safety shutdowns
- C. Documentation that certifies the standby generator will meet the current Environmental Protection Agency (EPA) and any other state or local emission standards for stationary compression ignition internal combustion engines.

1.04 OPERATING AND MAINTENANCE MANUALS

- A. Identify the size, model and features for each item.
- B. Furnish operating instruction manuals outlining step-by-step procedure required for system startup and operation, including manufacturer's name, model number, service manual parts list and brief description of all equipment and basic operating features. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
- C. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or

components not related to equipment furnished must be removed or crossed out. *O&M manuals must be individually tailored to the project and equipment as furnished.*

- D. Furnish maintenance instruction manuals outlining maintenance procedures, including a troubleshooting guide listing possible breakdown and repairs, and a simplified connection wiring diagram for the system.
- E. Copy of warranties issued on the installation, showing dates of expiration.
- F. Refer to Specification Section 16010 for additional requirements.

1.05 QUALITY ASSURANCE

- A. Contractor to ensure that concrete pad, conduit, conductors and branch circuit device ratings are suitable for the equipment supplied. Contractor shall coordinate with the generator set manufacturer for proper conduit stub up locations prior to installation.
- B. Contractor shall review the installation of the generator and all related equipment as indicated on the Drawings with the generator manufacturer's representative prior to submittal or shop drawing preparation. Any concerns with the installation as designed shall be brought to the attention of the Engineer immediately. Failure of the generator to operate properly due to confinements of the installation, whether by design or not, will be corrected by the Contractor at no cost to the Owner.
- C. The generator set manufacturer shall be responsible for and guarantee that the standby generator will operate at full load for 16 hours continuous at the location indicated on the Drawings. Any upgrading of components or modifications to the generator set required for proper operation (larger radiator, remote mounted radiator, fuel cooler, air intakes/ventilation, louvers, etc) shall be done at no cost to the Owner.
- D. The standby generator shall meet the latest Environmental Protection Agency (EPA) emission standards adopted by the authority having jurisdiction in the location where this generator will be installed.
- E. Where required by the EPA, State or other authority having jurisdiction, the Contractor shall be responsible for obtaining an Air Quality Permit for the Owner to operate the standby generator. The permit shall be obtained from the Arizona Department of Environmental Quality and/or any other authority having jurisdiction. The permit shall be filled out in the Owners name. Permit cost will be reimbursed by the Owner.

1.06 WARRANTY AND SERVICE

- A. A manufacturer's warranty shall be furnished on all components, parts, assemblies and performance of the generator against defects in materials and workmanship for a period of 2-years from the date of shipment. Warranty shall include parts, labor and travel expenses.

- B. The equipment manufacturer must have a local service center within a 400-mile radius of the project site with stocked spare parts and staffed with trained, full-time employees who are capable of performing testing, inspecting, repair, and maintenance services.

1.07 MANUFACTURERS

- A. Caterpillar Tractor Co., Peoria, IL
- B. Cummins Power Systems, Minneapolis, MN
- C. Generac Power Systems, Waukesha, WI

PART 2 -- PRODUCTS

2.01 GENERAL

- A. The engine, generator and all associated equipment as specified herein shall provide standby power during periods of normal power failure from utility.
- B. The engine-generator set shall consist of one engine and one generator.
- C. The engine-generator set shall be mounted on a structural steel frame or skid. Vibration isolators suitable to prevent transmission of vibration to the concrete pad shall be provided between the set and the frame.
- D. The engine-generator set shall have a minimum standby power KW rating as indicated on the Drawings at 0.80 power factor. Apply all temperature and elevation derates as necessary to verify that the minimum generator KW ratings indicated are correct.
- E. The generator shall operate at a speed not to exceed 1,800 rpm, and have an output voltage and phasing to match that of the *Normal* source.
- F. Instantaneous voltage dip for all possible sequences of load application and motor starting for loads described in conditions of service shall not exceed 30 percent of nominal voltage. Instantaneous voltage dip for step starting the loads as indicated below shall not exceed 30 percent of nominal voltage.
- G. Frequency regulation shall be isochronous from no load to rated load.
- H. Voltage regulation from no load to rated load shall have cyclic variations in RMS voltage not to exceed +/- 1.0 percent and a speed variation not to exceed +/- 5.0 percent of rated speed.

2.02 GENERATOR:

- A. Generator shall be rated for standby duty; shall be a 4-pole rotating field, engine-driven, direct-connected, synchronous type with amortisseur windings. Generator frame shall be dripproof with all openings guarded. Bearings shall be a single, prefabricated, sealed ball type.
- B. Generator insulation shall be Class H in accordance with NEMA Standard MG1-1.65 and BS2757. 125°C temperature rise at standby power rating.

- C. The AC generator, voltage regulator and exciter shall be designed and manufactured by the generator set manufacturer.
- D. Voltage regulator shall be an automatic, temperature compensated, solid-state type with a manual adjustment range of plus or minus 5 percent of rated voltage. The voltage regulator shall be equipped with 3-phase RMS sensing, overvoltage and overexcitation protection. Overvoltage and overexcitation protection features shall latch requiring the generator to be shutdown for reset.
- E. Exciter shall be brushless with full-wave silicon diodes mounted on the rotating shaft with a surge suppresser connected parallel with the field winding. Exciters utilizing field discharge resistors is not acceptable. Minimum rating of exciter shall be as indicated in NEMA Std. MG-1-22.16.
- F. Fast acting fuses or other protective devices shall be incorporated where failure of regulator or exciter components could result in damage to the generator field or exciter windings.
- G. Voltage regulator and static exciter shall be mounted in generator control panel or elsewhere so as to protect from and isolate from vibration.
- H. Generator and exciter shall conform to all applicable requirements of NEMA Standards, Publication MG1-1987, for Motors and Generators. Generators and exciters shall also conform to ANSI Standards C50.5, Rotating Exciters for Synchronous Machines and C50.12 Salient Pole Synchronous Generators and Condensers, as applicable.
- I. A permanent magnet generator (PMG) shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by nonlinear SCR controlled loads on the generator. The PMG shall sustain main field excitation power for optimum starting and to sustain short circuit current for selective operation and coordination of system overcurrent devices.
- J. Generator lead terminal box shall be of sufficient size to accept and terminate conductors as indicated on the Drawings. Field terminations to the generator leads shall be furnished with the proper terminal lugs suitable for the conductor size(s) as indicated on the Drawings.

2.03 DIESEL ENGINE

- A. Heavy-duty compression-ignition, cold-starting diesel type arranged for direct connection to an alternating current generator. It shall be a current model of a type in regular production by a manufacturer regularly engaged in building this type of diesel engine.
- B. Engine shall have at least a published intermittent brake horsepower rating at specified generator speed required by generator at rated full load output and shall operate without undue heating, vibration, or wear.
- C. Engine shall be four-cycle and may be naturally aspirated, or scavenged.
- D. Engine shall operate on *low sulfur* No. 2 diesel fuel oil.

- E. An electronic governor consisting of a speed sensor, adjustable electronic control and an actuator to provide automatic isochronous generator set frequency control.
- F. Performance, materials, and workmanship shall be in accordance with Diesel Engine Manufacturers Association standard practices.

2.04 FUEL STORAGE SYSTEM

- A. Provide a double-wall fuel tank with spill containment under the structural steel base. As a minimum the tank shall incorporate threaded pipe connections for fuel level gauge, fuel leak detection, low fuel level sensor, fuel suction line, fuel return line, vent, drain and a 1" spare port. Leak detection and a low fuel level sensor shall be pre-wired to the generator control panel with dry contacts for remote monitoring.
- B. Tank shall have capacity to operate generator at full load for 24-hours minimum.
- C. **Tank design shall be such that gauges, control panel and operating mechanisms (circuit breaker handle, emergency stop button, keyed switch, etc) are not located more than 72-inches above the concrete pad.**

2.05 ENGINE FUEL SYSTEM

- A. Diesel fuel system shall consist of an engine-driven, positive displacement fuel supply pump, fuel filters, and a secondary contained fuel piping system.
- B. Fuel filters shall be replaceable without breaking any fuel line connection or disturbing fuel pumps or any other part of engine. Oil filters shall be conveniently located ahead of injection or circulating pump so that fuel is thoroughly filtered before it reaches injectors. Screens or filters requiring cleaning or replacement shall not be used in injection or circulating pump, or in injection valve assemblies.
- C. Water separators shall be furnished to separate the water from the diesel fuel. A probe to detect water in the diesel fuel shall be provided to activate the Generator Failure/Malfunction alarm when the presence of water is detected in the fuel.

2.06 ENGINE COOLING SYSTEM

- A. The generator set shall be supplied with a closed-loop, skid-mounted radiator with a belt-driven fan and integral jacket water circulating pump.
- B. Provide radiator of sufficient capacity to operate the engine generator set at full load in 100°F ambient temperature at site elevation for 16 consecutive hours.
- C. Provide water jacket heater(s) to provide positive water circulation, thermostatically controlled to operate between 100 and 120°F. Voltage shall be 120V for 2kW and below or 240V, 1Ø for heaters over 2kW. Heater shall be equipped with a power cut-off relay and shutoff valves at both inlet and outlet sides.

2.07 ENGINE LUBRICATION

- A. Provide full pressure system, supplying oil to all surfaces requiring lubrication. Circulation shall be by positive displacement pump. Full flow-type filters or filters with bypass feature shall be included. Filter elements shall be replaceable without disconnecting oil piping. Provide an oil cooler, if recommended by engine manufacturer, to properly lubricate engine at full rated generator load.

2.08 ENGINE APPURTENANCES

- A. Furnish engine with following appurtenances:
 - 1. Combustion air cleaner of oil bath type or dry replaceable filter type. A tube shall connect crankcase breather with air cleaner to prevent accumulation of objectionable smoke and fumes.
 - 2. Exhaust silencers for residential silencing complete with drains and flexible stainless-steel connection. Design and provide exhaust piping system, including seismic analysis, vibrations isolators, expansion joints.
 - 3. Exhaust piping shall be steel with flexible connections. The exhaust piping shall include a condensation trap(s) with drain valve(s) to prevent water from entering the engine. An exhaust rain cap and all necessary fittings shall be provided on the stack outlet.
- B. The generator set shall be supplied with a molded case, thermal magnetic type main circuit breaker, mounted and wired. Voltage and amperage shall be as indicated on the Drawings. Amperage Interrupting Capacity (AIC) shall match or exceed maximum RMS symmetrical short circuit current available from the generator during a bolted phase-to-ground fault.

2.09 ENGINE ELECTRICAL SYSTEM:

- A. Electrical system shall include batteries, electric starter, voltage and current-regulated charging generator or alternator, and a separate battery charger. Both a manual starting switch and fully automatic starting from a remote pilot device shall be furnished.
- B. Batteries and starter shall be of suitable capacity to start engine through three starting cycles of 10 seconds each. If the generator has not started after three starting cycles, it shall be shutdown automatically until manually reset.
- C. Battery charger shall be automatic, two rate type providing for equalizing charge and continuous taper charging. Output characteristics shall match requirements of battery furnished. Provide charger suitable for operation on 120 volt, single-phase, 60-Hertz current to be rated not less than 10-amp direct current. Furnish battery charger with following features:
 - 1. Direct current voltage regulation: plus or minus 2 percent for variations in line voltage of plus or minus 10 %.
 - 2. Direct current voltmeter and direct current ammeter, each with suitable scales.
 - 3. Automatic surge suppresser.

4. Automatic current limiting to prevent overloading due to engine cranking, shorted output or reversed battery connections.
 5. Alternating current line fusing.
 6. Built-in equalize charge timer.
 7. Integral protection to prevent battery discharge through charger on loss of alternating current line voltage.
 8. Set of normally open dry contacts to close on Low Battery Alarm.
- D. Provide battery rack with battery hold-down clamps to accommodate starting batteries within the generator enclosure.

2.10 CONTROL PANELS

- A. The generator set shall be provided with a microprocessor based control system to provide automatic starting, monitoring and control functions for the generator set. The control panel shall be UL 508A labeled and manufactured by the generator manufacturer specifically for the generator set supplied.
- B. The control panel shall be mounted on the generator with vibration isolators. The maximum height above grade or viewing platform to the center of the highest digital display or meter shall not exceed 66". Where the control panel digital display mounting height exceeds this, it shall be reinstalled by the generator manufacturer **or** the Contractor shall fabricate a steel framed 36" x 36" viewing platform with aluminum grating and stairs at no cost to the Owner.
- C. Control panel doors and all door-mounted devices shall be gasketed and dust-tight. All remote control and monitoring signals shall be terminated on terminal blocks.
- D. The control panel shall be provided with the following controls/meters:
1. RUN/OFF/AUTO selector switch (3-position switch or keypad)
 2. Mushroom head, maintained EMERGENCY STOP pushbutton
 3. ALARM RESET pushbutton
 4. PANEL LAMP pushbutton to illuminate controls and meters
 5. Voltmeter
 6. Ammeter
 7. Frequency meter
 8. Kilowatts (kW)
- E. The following status and alarms shall be displayed on the digital display panel:
1. Engine Oil Pressure (psi)
 2. Low Oil Pressure Alarm
 3. Engine Coolant Temperature (°F)
 4. High & Low Coolant Temperature Alarms
 5. Overcrank Alarm

6. Overspeed Alarm
 7. High & Low DC Voltage Alarms
 8. Low Fuel Alarm
 9. High & Low Output Voltage Alarms
 10. Under frequency Alarm
 11. Overload/Overcurrent Alarm
 12. Ground Fault Alarm
 13. Engine Speed (RPM)
 14. Running Time (hours)
 15. Battery Voltage (DC Volts)
- F. The control system shall include a ground fault monitoring relay with an adjustable time delay for alarm. The ground fault relay shall be used for alarm monitoring only, not to trip the main circuit breaker, unless otherwise indicated.
- G. Form "C" dry contacts shall be provided for remote monitoring of alarms as indicated on the Drawings. The contacts shall be rated 2A at 30 VDC, minimum.

2.11 OUTDOOR WEATHERPROOF ENCLOSURE

- A. Provide a weatherproof enclosure for the engine, and associated components.
1. Enclosure shall include an updraft duct with bird screen on the radiator end to direct the generator's discharge air upward.
 2. Enclosure to have fully gasketed doors for access to all portions of the generator that requires any maintenance. All doors to have rain molding above door opening, stainless steel hinges and a two point latch to allow the doors to be completely removed. Handles to be the key locking type.
 3. As a minimum, the enclosure roof, walls and doors shall contain 1/2" deep support ribs with 16 gauge minimum exterior steel with interior sound attenuation insulation. Insulation shall consist of minimum #6 density wool held in place with a perforated liner.
 4. All seams shall be caulked with a sealer prior to painting. Paint exterior surfaces of equipment with two coats of acceptable oil and heat-resistant paint, applied after surfaces have been thoroughly cleaned and prepared with suitable priming coat. **Exterior color shall be desert tan unless otherwise directed by the Owner.**
 5. Provide fixed louvers with a screened cover over air openings sized as required for proper airflow.
 6. The enclosure shall have a steel base channel constructed to drop *over* the generator set with anchor boltholes for fastening to the generator frame or concrete slab.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Install unit complete and make operational.
- B. Install muffler(s) horizontally above the unit.
- C. Provide ½-inch (12mm) copper drain with draincock on bottom of muffler to nearest drain for periodic draining of muffler.
- D. Provide vibration isolation of exhaust equipment to prevent transfer of vibration into building components.
- E. Provide vibration isolators suitable to prevent transmission of vibration from the generator frame to the concrete pad or building floor. Securely anchor the generator frame to the concrete pad/floor with galvanized anchor bolts shall be furnished by engine-generator set manufacturer. Obtain from supplier of engine-generator set a drawing giving location and size of foundation bolts for unit proposed, in sufficient time to be available when needed to place foundation.
- F. Electrical equipment and materials shall be listed by UL wherever standards have been established by that agency.

3.02 WIRING AND CONNECTIONS

- A. Provide conduit, wiring, and connections required and recommended by generator supplier. All conduit and fuel line stub-ups shall be contained within the generator set frame.
- B. Connect generator frame to the electrical service grounding system as indicated on the Drawings. The generator neutral conductor shall be run to the service entrance equipment isolated from ground via the automatic transfer switch and bonded to the service equipment neutral bus.
- C. For 3Ø, 3W standby power supply: Install a main bonding jumper (MBJ) between the generator neutral and the generator ground bus/frame. Size as indicated on the Drawings for the service entrance section.
- D. For 1Ø, 3W standby power supply: Do not install a main bonding jumper (MBJ) between the generator neutral and ground bus/frame. If the generator is furnished with a MBJ, the Contractor shall remove it before conducting any standby power system testing. The neutral conductor shall be run to the service entrance equipment isolated from ground via separate terminals in the automatic transfer switch and bonded to the service equipment neutral bus.

3.03 TESTING

- A. On-site Tests:
 - 1. Unless certified in the factory test report, the generator manufacturer must pressure test the fuel line and the secondary containment piping in accordance with the Uniform Fire Code and any applicable Local, State, or Federal requirements.
 - 2. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown and return to normal. Record the

time to achieve standby power after loss of the *Normal* power source. Record the time to retransfer back to the *Normal* power source.

3. Verify fuel tank is full, then provide a full load test for the aeration system standby generator utilizing a portable resistive load bank, for eight (8) hours. Full load shall be the kVA as indicated on the generator set nameplate. Supply all fuel and portable test bank required for testing.
 - a. Record in 20 minute intervals during the on-site test:
 - 1) Time of Day
 - 2) Kilowatts
 - 3) Amps
 - 4) Voltage
 - 5) Coolant temperature
 - 6) Air temperature
 - 7) Frequency
 - 8) Oil pressure
 - 9) Battery charging rate
 - b. Test all alarm and shutdown circuits by simulating fault or failure conditions.
 - c. Refill fuel tank after full load test is complete and record the volume of fuel required to refill the tank.

3.04 TRAINING

- A. Operator training shall be provided by the generator manufacturer's factory-trained representative.
- B. The training shall be conducted at the project site.
- C. The training session shall include up to four Owner's representatives.
- D. The training session shall be a minimum of four (4) hours, conducted on a normal workday as decided upon by the Owner.
- E. The training session shall include the proper maintenance and operation of the standby generator and automatic transfer switch.

****END OF SECTION****

SECTION 16260

AUTOMATIC TRANSFER SWITCH

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Automatic transfer switches, 600V and below with accessories as indicated herein.

1.02 REFERENCE:

- A. STANDARDS:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. ICS, General Standards for Industrial Control and Systems.
 - 2. Institute of Electrical & Electronic Engineers (IEEE).
 - 3. Underwriters Laboratory (UL) 1008
 - 4. National Fire Protection Association (NFPA):
 - a. NFPA-110, Standard for Emergency and Standby Power Systems.

1.03 SUBMITTALS:

- A. Submit the following:
 - 1. Product Data: Provide catalog data on all components in accordance with this specification.
 - 2. Drawings: Interconnection wiring diagrams for the generator control systems indicating control connections between the generator and automatic transfer switch. Power and control wiring conduit entrance locations.

1.04 OPERATING AND MAINTENANCE MANUALS

- A. Identify the size, model and features for each item.
- B. Furnish operating instruction manuals outlining step-by-step procedure required for system startup and operation, including manufacturer's name, model number, service manual parts list and brief description of all equipment and basic operating features. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
- C. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or components not related to equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
- D. Furnish maintenance instruction manuals outlining maintenance procedures, including a troubleshooting guide listing possible breakdown and repairs, and a simplified connection wiring diagram for the system.

- E. Copy of warranties issued on the installation, showing dates of expiration. Warranty period shall begin at date of substantial completion.
- F. Refer to Specification Section 16010 for additional requirements.

1.05 QUALITY ASSURANCE

- A. Contractor to ensure that conduit size and wire quantity, size, and type are suitable for the equipment supplied.
- B. Comply with the following Codes and Standards:
 - 1. UL listing and labeling for materials.
 - 2. UL 1008
 - 3. NFPA-70.

1.06 WARRANTY AND SERVICE

- A. A manufacturer's warranty shall be furnished on all components, parts, assemblies and performance of the transfer switch for a period of 2-years from the date of substantial completion. Warranty shall include parts, labor and travel expenses.
- B. The equipment manufacturer must have a local service center within a 400-mile radius of the project site with stocked spare parts and staffed with trained, full-time employees who are capable of performing testing, inspecting, repair, and maintenance services.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. ASCO
- B. Russelectric
- C. Zenith
- D. Or equal

2.02 MATERIALS

- A. The transfer switch shall be provided with ratings, number of poles/wires and installed as indicated on the Drawings. The short circuit withstand ampacity shall meet or exceed the indicated AIC rating of the electrical equipment immediately connected to the load side of the transfer switch. The transfer switch shall be capable of switching all classes of loads while under full load.
- B. The transfer switch shall be provided with a NEMA rated enclosure as indicated on the Drawings.
- C. Load transfer shall be delayed transition, three position (center off) electrically and mechanically interlocked contactors. Interlocked circuit breakers are not acceptable.

- D. Main switch contacts shall be silver or have silver alloy surfaces, arcing tips and arc extinguishing devices. Transfer switch shall be capable of closing on an inrush current 20 times its full load rating without contact damage and capable of withstanding a system short circuit fault until the overcurrent device trips. Total transfer time in either direction shall not exceed one-half second. Interlock *Normal* and *Emergency* contactors both mechanically and electrically so that both cannot be closed at any one time.
- E. Switching contactors and cable connections shall have a transparent protective cover to protect operating personnel from accidental contact and allow visual determination of the transfer switch position.
- F. The transfer switch shall be provided with a door mounted, 3-position selector switch or keypad with password for TEST, NORMAL and RETRANSFER manual transfer control which will activate the transfer switch with the same contact-to-contact speed as automatic operation.
- G. There shall be a separate adjustable time delay (0-2 min.) for transferring power from the *Normal* to *Emergency* and retransferring back.
- H. As a minimum, the transfer switch shall be provided with the following:
1. Open transition type controls necessary for a delay in transfer.
 2. Temperature compensated, solid-state voltage sensors shall simultaneously monitor all phases of both normal and standby power sources. Transfer from *Normal* to *Emergency* source shall occur when the *Normal* source voltage and frequency drops below an adjustable 85-95 percent nominal for a period of time as set by the time delay to transfer (0-2 minutes). Retransfer back to *Normal* shall occur when the *Normal* source has been restored to nominal an adjustable 85-95 percent for a period of time as set by the time delay to retransfer (0-30 minutes).
 3. An adjustable time delay (0-5 seconds) with a suitable contact for starting an engine generator upon loss of *Normal* power.
 4. Transfer of power to the standby source shall occur within 10 seconds of loss of *Normal* power.
 5. 250V, 10A, Form "C" auxiliary and control contacts as follows:
 - a. Two contacts that are closed when the transfer switch is in the *Normal* position.
 - b. Two contacts that are closed when the transfer switch is in the *Emergency* position.
 6. After retransfer of power from a standby generator source, the generator shall remain running for an adjustable time period as set by a timing relay (0-10 minutes).
 7. Separate pilot lights to indicate the presence of each source and transfer switch position.

8. Separate status indicators to indicate the presence of each power source, signal to start engine generator, transfer/retransfer timing, transfer/retransfer complete and stop generator timing.
9. Full rated lugs for *Normal*, *Emergency* and *Load* conductors as indicated on the Drawings.
10. Terminal blocks for all control and monitoring field-wiring connections as indicated on the Drawings and as specified herein.
11. A 7-day, 24-hour adjustable exerciser clock or, if indicated on the Drawings, a remote start/stop input shall be capable of exercising the generator set under *No Load* condition.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Install where indicated on plans. Mount unit such that it is level and plumb.
- B. Prior to installation, coordinate with other trades to verify conduits have adequate space to leave and enter the switch enclosure and for required code clearance. A minimum working clearance as defined by the NEC 110-26 shall be provided.
- C. Install in accordance with NFPA 70 and all applicable local codes and regulations.

3.02 TESTING

- A. Factory Tests:
 1. Provide factory production tests in accordance with NEMA standards and NFPA standard 110. Check and set all instruments and safety devices.
- B. On-site Tests:
 1. Simulate utility power failure to verify proper operation of the automatic transfer switch, automatic starting and stopping of the standby generator and retransfer back to utility when utility power is resumed. Record the time to achieve standby power after loss of the *Normal* power source. Record the time to retransfer back to the *Normal* power source.
 2. Verify all status and alarm signals being monitored remotely.
 3. Coordinate with the Owner for programming the exerciser clock settings.

3.03 TRAINING

- A. The Contractor shall provide training by a manufacturer's factory-trained representative.
- B. The training shall be conducted at the project site.
- C. The training session shall include up to four Owner's representatives.
- D. The training session shall be a minimum of two (2) hours, conducted on a normal workday as decided upon by the Owner.

- E. The training session shall include the proper maintenance and operation of the automatic transfer switch.

****END OF SECTION****

SECTION 16401

SERVICE ENTRANCE SECTION

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Furnish and install electrical service entrance section consisting of utility metering and service disconnect.

1.02 SUBMITTALS

- A. Product Data: Submit catalog cuts and manufacturer's descriptive literature for approval for:
 - 1. Service Entrance Section
- B. Shop Drawings:
 - 1. Submit drawings showing dimensions and dimensional clearances within the structure.
 - 2. Include metering per serving utility requirements and main circuit breaker.
 - 3. All electrical characteristics (voltage, phasing, amperage, bracing, interrupting capacity).
- C. Serving electric utility company coordination:
 - 1. The Contractor shall submit the above listed information to the local serving utility for approval of proposed service entrance equipment. The Contractor shall submit written approval from the local utility to the Engineer.

1.03 QUALITY ASSURANCE

- A. Meet requirements of NEC (NFPA 70)
- B. Codes and Standards:
 - 1. NFPA 70-NEC
 - 2. NEMA
 - 3. U.L. listed
 - 4. ICEA
 - 5. IEEE
 - 6. ANSI
 - 7. Local Utility Company
- C. Service equipment shall bear markings "Suitable for Use as Service Equipment" or be UL listed as "Service Equipment."
- D. The manufacturer of the service entrance equipment shall be the manufacturer of the circuit protective device, and other accessories within.
- E. The manufacturer of the service entrance equipment shall be ISO 9000, 9001 or 9002 certified.

- F. The manufacturer of the service entrance equipment shall have produced similar electrical equipment for a minimum period of five (5) years. If requested by the Engineer, a list of installations with successful operation of similar equipment shall be provided demonstrating compliance with this requirement.

1.04 RELATED WORK

- A. Division 16, Electrical

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Sun Valley Electric
- B. Milbank
- C. Eaton
- D. Square D Company
- E. Or equal

2.02 GENERAL CONSTRUCTION

- A. The equipment specified herein shall have the following ratings:
 - 1. Voltage: As indicated on the Drawings
 - 2. Phasing: As indicated on the Drawings
 - 3. Alternating Current Frequency: 60 Hz
 - 4. Bus Bracing: As indicated on the Drawings
 - 5. Bus Amperage: As indicated on the Drawings
 - 6. Protective Device Mounting: Fixed
 - 7. Enclosure: NEMA 3R, surface mounted as indicated on the Drawings.
- B. The service equipment shall consist of an assembly furnished with an incoming line section (overhead or underground as indicated on the Drawings) and a separate barriered-off utility metering compartment complete with hinged sealable door(s). Bus work shall include provisions for mounting utility company current transformers and potential taps or transformers as required by utility. Lugs shall be provided in the incoming line section for connection of the feeder conductors.
- C. The internal components and bussing shall be completely enclosed (metal clad) with dead front construction. All edges of front covers or hinged front panels shall be formed.
- D. All bus bars shall be silver or tin plated copper.
- E. Provide a full capacity neutral landing lug or bus if a three phase, four wire or single phase, three wire system is indicated on the Drawings.
- F. Mechanical type terminals shall be provided for all line and load terminations suitable for copper cable rated for 75°C.

- G. All exterior and interior steel surfaces of the assembly shall be properly cleaned and provided with a rust-inhibiting phosphatizing coating. Color and finish shall be ANSI 61, unless noted otherwise.

2.03 CIRCUIT BREAKER TYPE PROTECTIVE DEVICES

- A. Circuit breakers shall be of the molded case type and shall provide overcurrent protection with inverse time and instantaneous tripping characteristics.
- B. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy, and arc extinction shall be accomplished by means of arc chutes.
- C. Circuit breakers shall have a minimum symmetrical interruption capacity as indicated on the Drawings
- D. Circuit breakers shall have thermal magnetic trip units and inverse time-current characteristics.
- E. The Contractor shall be responsible for the setting of the adjustable protective parameters of the circuit breakers to ensure proper system protection and coordination.

2.04 ARC FLASH WARNING LABEL

- A. Furnish each service entrance section with an Arc Flash Warning label to read:

“WARNING
Arc Flash and Shock Hazard
Appropriate (PPE) Required”

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Furnish and install service entrance equipment as indicated on the Drawings, in accordance with the serving utility’s requirements, in accordance with the NEC and all applicable local codes and regulations.
- B. Install main bonding jumper and provide grounding of service entrance equipment per the NEC, serving utility and applicable local code requirements.

END OF SECTION

SECTION 16450

GROUNDING

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Grounding and bonding of electrical equipment, raceways and specialized systems, including testing.

1.02 SUBMITTALS

- A. Manufacturer's data for the following:
 1. Connection methods
 2. Ground rods
 3. Ground rod wells

1.03 SYSTEM DESCRIPTION

- A. Ground electrical equipment, conduits, supports, cabinets, and switchgear in accordance with NFPA 70 (NEC) and as shown on the Drawings, the intent being a system ground and an equipment ground.

1.04 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (refer to Section 16010):
 1. IEEE 81-1962--IEEE Recommended Guide for Measuring Ground Resistance and Potential Gradients in the Earth.
 2. NFPA 70 (NEC)
 3. NEMA
 4. UL listing
 5. MIL Handbook 419

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Ground Rods:
 1. Anderson Electric Corp.
 2. Copperweld Corp.
 3. Harger

2.02 MATERIALS

- A. Ground rods shall be copperclad rods $\frac{3}{4}$ -inch in diameter and 10-feet long unless indicated otherwise on the Drawings.
- B. Ground rod wells shall be $8\frac{1}{2}$ -inch diameter constructed of reinforced concrete with a reinforced concrete removable cover stamped "GROUND" as manufactured by Christy or equal.

- C. Connectors, mechanical lugs or wire terminals shall be used only to bond ground wires, junction and panel boxes.
- D. Grounding conductors shall be stranded copper, size as indicated on the Drawings or as required by the NEC. Grounding conductors shall be bare or contain green insulation.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Where mechanical lugs are not welded or fastened with a threaded bolt, surfaces shall be thoroughly cleaned and paint scraped to bare metal before connections are made to insure good metal-to-metal contact.
- B. An equipment grounding conductor must be installed in each conduit with power conductors or, in the case of multi-conductor cable, run inside the cable sheath.
- C. The Contractor shall bond the electrical equipment pad rebar to the service grounding electrode system.
- D. A main system ground, bare copper conductors, size as indicated, shall be run in PVC conduit from the service entrance section to the grounding electrode system as indicated on the Drawings.
- E. Connections to ground rods shall be exothermically welded. Ground rod connections shall be done in a ground rod well for inspection purposes. Ground rod connections may also be done with Burndy "HYTAP" type connectors.
- F. All enclosure doors with 120V mounted devices shall be bonded to the enclosure ground bus.

****END OF SECTION****

SECTION 16470
PANELBOARDS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Lighting and power distribution panelboards as indicated on the Drawings and as specified herein.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data demonstrating compliance with this specification and the Drawings. Information shall include but not be limited to:
1. A panel schedule indicating branch circuit number, size and type of individual circuit breakers, interrupting capacity of the device and number of poles.
 2. Short circuit current bracing of the panel.
 3. Bus material and mounting type.
 4. Demonstrate means of identification of each circuit and of each panel by mark corresponding to the Drawings. Explain any deviations.
 5. Clearly indicate all dimensions and that it has been verified that the equipment will fit into place.
 6. Indicate ground bus kits.
 7. Integral surge protective device (SPD) documentation, where applicable.
- B. Test Data: Submit test reports on integrated panel.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (refer to Section 16010):
1. NEMA
 2. UL listing
 3. NFPA 70 (NEC)
 4. W-P-115a Power Distribution, current edition

1.04 RELATED WORK

- A. Section 16010 – Basic Electrical Requirements
B. Section 16195 – Electrical Identification
C. Section 16450 - Grounding
D. Section 16475 – Overcurrent Protective Devices

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Square D Company

- B. Eaton
- C. General Electric Co.

2.02 MATERIALS

- A. Panelboards shall have the following minimum requirements:
 - 1. UL listed with copper bus bars of 98 percent conductivity and minimum cross sectional area based on UL 67 for heat rise. Bus size and ratings shall be in accordance with UL 67. Minimum bus voltage, amperage and short circuit withstand rating shall be as indicated on the Drawings or as required per NEC.
 - 2. Copper bars shall be provided for terminating equipment grounding conductors and neutral conductors, where applicable.
 - 3. Terminals shall be UL rated for use with copper or aluminum conductors.
 - 4. Panelboards shall include a main circuit breaker or solderless main lugs as indicated on the Drawings. Lugs for main lug only panelboards shall be sized to accommodate the incoming power supply conductors.
 - 5. Fully rated feed-thru lugs shall be provided where indicated.
 - 6. Branch breakers shall be the bolt-on type, unless otherwise indicated.
 - 7. A framed directory pocket shall be provided on the inside door with 1/16-inch thick glass or plastic cover and typed written directory card.
 - 8. A manufacturer's stamped steel nameplate shall be riveted to the exterior indicating voltage, amperage, phases and short circuit rating.
 - 9. Where indicated, circuit breakers shall have a fixed handle padlock attachment capable of locking the circuit breaker in the off position.
 - 10. Enclosures shall be constructed of galvanized steel with a baked-on polyester power coated ANSI-61 light gray finish. Panelboard doors shall consist of a bolt-on steel cover with an integral hinged door for circuit breaker access (door-in-door). Unless otherwise indicated on the Drawings, NEMA ratings shall be as follows:
 - a. Indoor flush mounted: NEMA 1
 - b. Indoor surface mounted: NEMA 12
 - c. Outdoor: NEMA 3R, gasketed with tamperproof screws
 - 11. Three phase panelboards shall have a minimum of 5-inch wide top and bottom gutters and 6-inch side gutters. Power distribution panelboards may be larger to accommodate larger branch breakers or subfeed breakers.

2.03 SURGE PROTECTION DEVICE (SPD)

- A. Where indicated, panelboards shall be furnished with an integral Type 2 SPD specifically designed for installation in the panelboard. The unit shall have the following features and functions:
 - 1. ANSI/UL 1449 Third Edition.
 - 2. UL 1283 listed for high frequency noise.

3. UL 845 listed for motor control centers.
4. All modes of protection: L-N, L-G, L-L, N-G
5. The minimum Surge Current Capacity per phase shall be as indicated on the Drawings.
6. The maximum UL 1449-Third Edition VPR for the protection of each mode shall not exceed the following:

<u>Mode</u>	<u>277/480</u>	<u>120/240V</u>
Line-Neutral	<u>1200 VAC</u>	<u>700 VAC</u>
Line-Ground	<u>1200 VAC</u>	<u>1000 VAC</u>
Neutral-Gnd	<u>1200 VAC</u>	<u>700 VAC</u>
Line-Line	<u>2000 VAC</u>	<u>1200 VAC</u>
7. Status pilot lights to indicate unit is powered and operating properly. Separate pilot light(s) shall indicate unit or individual phase protection module failure.
8. Form C alarm contacts for remote monitoring unit failure.
9. Minimum 5 year warranty.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Prior to installing panelboards, verify conduits have adequate space to enter the panelboard and to provide the required code clearance. A minimum working clearance as defined by the NEC 110-26 shall be provided. Whether the panelboard is installed indoors or outdoors, the working space as defined in Table 110-26(a) of the NEC shall apply.
- B. Panelboards shall be installed such that the highest circuit breaker handle is not more than 6'-7" above finished floor.
- C. Provide a means of keeping unauthorized hands out of live panels during construction when panelboard fronts have not been installed.
- D. Complete the panelboard schedule by accurately typing in a brief load description for the appropriate circuit number. Place a copy of the panelboard schedule in the pocket of the panelboard door.
- E. Each branch circuit conductor shall be clearly identified by color as to the phase connection. Wiring in panels shall be neat with rounded corners and tied in bundles with approved ties. See Section 16120.
- F. Where a common neutral is run for more than one branch circuit, the phase conductors shall be connected to separate, consecutive phases in order that the neutral will carry only the unbalanced current in each phase. Neutral conductors shall be same size as phase conductors unless specifically noted otherwise.
- G. Surface Mounted Panelboards:

1. Shall be installed plumb and level, and in accordance with manufacturer's directions.
 2. Surface mounted panelboards shall be securely bolted to the walls.
- H. Panelboards Mounted in distribution switchboards:
1. Panelboards in distribution switchboards shall be installed by the switchboard manufacturer.

3.02 BALANCING

- A. Panelboard circuiting shall be as indicated on the Drawings whenever possible. Additional loads shall be placed to balance loads between phases as much as possible.

****END OF SECTION****

SECTION 16475

OVERCURRENT PROTECTIVE DEVICES

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Overcurrent Protective Devices such as fuses and circuit breakers.

1.02 SUBMITTALS

- A. Fuses: Submit catalog cuts which indicate the fuse symbol and ampere rating for each disconnect or device.
 - 1. Submit manufacturer's data showing fuse name, symbol, voltage rating, UL class, interrupting capacity or I-squared time (I²t) characteristics and accessories.
 - 2. Fuse trip curves.
- B. Breakers: Submit catalog cuts that indicate type of breaker, size, trip, characteristics, interrupting capacity, and the specified features.

1.03 OPERATING AND MAINTENANCE MANUALS

- 1. Identify the size, model and features for each item.
- 2. Complete instructions regarding the operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
- 3. Refer to Specification Section 16010 for additional requirements.

1.04 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (see Section 16010):
 - 1. NFPA 70 (NEC)
 - 2. UL listing
 - 3. ANSI
 - 4. NEMA

1.05 RELATED WORK

- A. Division 16, Electrical

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Fuses:
 - 1. Bussmann Mfg. Div.
 - 2. Gould-Shawmut
 - 3. Little-Fuse

- B. Circuit Breakers:
 - 1. Schneider
 - 2. Eaton
 - 3. General Electric Co.

2.02 MATERIALS

- A. Fuses:
 - 1. Fuses up to 600 volts shall meet the following:
 - a. Be of the same manufacturer.
 - b. Shall NOT be shipped in fused switches.
 - c. Shall be stored in a safe, moisture free area until needed.
 - d. All dual element fuses shall have separate overload and short circuit elements. The overload element shall include a spring-assisted thermal unit. The thermal unit shall open on a temperature rise above 280 degrees Fahrenheit. Time delay for the overload element shall be at least 10 seconds at 500 percent of rated amperes.
 - e. When indicated on the Drawings or required by the local authority or serving utility, fuses shall be silver-sand UL Class R or Class L current-limiting fuses (low-peak dual element).
 - f. Motor branch circuit fuses rated 1/10 to 600 amperes shall be sized one ampere rating above the selected heater element. Fuse ampere rating shall not exceed 175 percent of motor FLA. Abnormal motor conditions requiring increased ampere ratings shall be referred to the Engineer. Fuses shall be UL Class R current-limiting dual element with time delay.
- B. Circuit Breakers:
 - 1. Low voltage breakers up to 600 volts shall meet the following:
 - a. Be quick-make, quick-break type.
 - b. Have toggle mechanism insuring full contact pressure until time of opening whether manually or automatically operated.
 - c. Thermal magnetic type to have inverse time tripping characteristics with fixed thermal trip action to hold on harmless momentary overload.
 - d. Adjustable trip setting shall be provided for all service entrance section main circuit breakers.
 - e. A short circuit condition shall cause the magnetic trip element to instantly trip without damage or injury.
 - f. Have non-welding, non-corroding contacts.
 - g. Be full-size with mechanism enclosed in molded bake-lite case, sealed to prevent tampering or unauthorized changes in calibration.

- h. Be UL listed and recognized.
- i. Meet NEMA standards.
- j. Be bolt-on type unless otherwise specified.
- k. Have contacts that operate in a multiple plate arc-quenching chamber vented to load side of breaker - UL listed.
- l. Be rated for AIC compatible with ratings of the panel or switchboard bus they are to be used in as indicated on the Drawings. Unless otherwise indicated, series rated devices are not acceptable. All overcurrent devices shall be fully rated.
- m. Be calibrated for operation in a minimum ambient temperature of 50 degree C.
- n. All multi-pole breakers shall have common trip.
- o. For multi-pole breakers shall require the same space as the equivalent number of single pole breakers. Wafer style breakers are unacceptable.
- p. Have operating handle that visually indicates “on”, “off”, or “tripped”.
- q. Be labeled to indicate circuit number(s) and load served.
- r. Be rated for 100% continuous operation where indicated on the Drawings.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Provide overcurrent protection for all wiring and equipment in accordance with NFPA 70, State or local codes, whichever is prevailing.
- B. Should nameplate data disagree with the size or application of an overcurrent protective device indicated on the Drawings, immediately bring it to the attention of the Engineer for a decision.
- C. Place a label inside each fused switch door. Label shall indicate fuse type, ampere rating and interrupting rating. Manufacturers’ labels are acceptable.
- D. Where blank spaces or spaces designated for future overcurrent devices are indicated on the Drawings, they shall be complete with bus links.

3.02 SPARE PARTS

- A. Furnish one spare set of three (3) of each size and type of fuse rated at more than 30 amperes, and 10 percent of each size and type of fuse rated 30 amperes or less, but in no case less than one set of three (3).

****END OF SECTION****

SECTION 16480

MINI-POWER CENTERS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Combination transformer/panelboard units commonly referred to by manufacturer trademark as “Mini-Power Center”.

1.02 SUBMITTALS

- A. Product Data: Provide catalog data on all components in accordance with this specification including the combination transformer/panelboard and circuit breakers contained within.
- B. Provide a panel schedule indicating each circuit breaker with load description.
- C. Provide the two-tier series rating of the mini-power center primary circuit breaker with the mini-power center branch circuit overcurrent device where the AIC on the branch circuit overcurrent device has a higher AIC rating than the mini-power center primary circuit breaker.

1.03 OPERATING AND MAINTENANCE MANUALS

- 1. Identify the size, model and features for each item.
- 2. Complete instructions regarding the operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. *O&M manuals must be individually tailored to the project and equipment as furnished.*
- 3. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or components not related to equipment furnished must be removed or crossed out. *O&M manuals must be individually tailored to the project and equipment as furnished.*
- 4. Refer to Specification Section 16010 for additional requirements.

1.04 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards:
 - 1. NEMA (Testing Standards BU 1.3.03 or 1.304)
 - 2. UL listing and labeling for materials.
 - 3. NFPA-70

1.05 RELATED WORK

- A. Specification Section 16195, Identification
- B. Specification Section 16475, Overcurrent Protective Devices

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Schneider
- B. Eaton
- C. General Electric

2.02 MATERIALS

- A. Mini-Power Centers shall have KVA rating as indicated on the Drawings.
- B. Mini-Power Center Units shall include integrally mounted and wired transformer primary and secondary main circuit breakers in accordance with NFPA 70 requirements.
- C. Transformer shall have 480V primary and 120/240V, 1Ø or 120/208V, 3Ø secondary as indicated on the Drawings.
- D. Transformer shall have 2-5 percent primary taps below normal. Transformer to be encapsulated in a sand-epoxy resin to protect against moisture, rust and corrosive environments.
- E. Bussing shall be copper.
- F. Branch circuit breakers shall be bolt-on type and as specified elsewhere in these specifications.
- G. Enclosures shall be cleaned, phosphatized and electrostatically powder coated and shall be UL Listed for outdoor use. A padlockable hinged access door shall be provided which maintains itself in the open position.
- H. Where the AIC rating of the primary circuit breaker is less than the short circuit rating of the electrical switchboard feeding the mini-power primary breaker, a two-tier series rated system must be furnished to provide adequate protection of the mini-power center. The mini-power center must be clearly marked and labeled by the manufacturer that specifically indicates its suitability for use with series rated systems as required by the NEC 110-22 as follows:

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Install where indicated on plans. Mount unit such that it is level and plumb.
- B. Prior to installing mini-power centers, coordinate with other trades to verify conduits have adequate space to leave and enter the tub and for required code clearance. A minimum working clearance as defined by the NEC 110-26 shall be provided.
- C. Securely fasten to wall of building or equipment with stainless steel bolts, nuts and lock-washers.
- D. Insert accurate panel schedule on inside of enclosure door or clearly write load description on mini-power center inner door next to each circuit breaker with a permanent black marker.

- E. Label each circuit conductor with its associated branch circuit number per Specifications Section 16195.
- F. Install nameplate on exterior of Mini-Power Center to indicate panel designation. Fasten nameplate using stainless steel self-tapping screws.
- G. Bond secondary of transformer to the service or grounding electrode system with copper grounding conductor sized as indicated on the Drawings or per NFPA 70.

****END OF SECTION****

SECTION 16481

MOTOR CONTROLLERS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Motor controllers and motor starters

1.02 SUBMITTALS

- A. Shop Drawings: Submit drawings which include, but not limited to, the following applicable data:
 - 1. Motor designation and horsepower
 - 2. NEMA starter sizes and overload type/sizes
 - 3. Enclosure type with interior and exterior elevations with dimensions
 - 4. Control transformer ratings
 - 5. Circuit breaker (or fuse) sizes
 - 6. Auxiliary contacts
 - 7. Control devices being utilized
 - 8. Point-to-point wiring diagram by the controller/starter manufacturer or a UL-508A approved system integrator
 - 9. Bill of material including spare parts being furnished
- B. Product Data: Submit manufacturer's data showing compliance with the Drawings and these specifications.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (see Section 16010):
 - 1. NFPA 70 (NEC)
 - 2. UL listing
 - 3. NEMA
 - 4. Horsepower application rated
 - 5. IEEE

1.04 JOB CONDITIONS

- A. Coordinate with motor manufacturer for whom starters are being furnished to verify starter selected will properly start, run and protect the motor it serves.

1.05 RELATED WORK

- A. Specification Section 16120 – Wires and Cables (600V or less)
- B. Specification Section 16195 – Electrical Identification
- C. Specification Section 16475 – Overcurrent Protective Devices

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Schneider
- B. Eaton
- C. Allen-Bradley
- D. General Electric Co.

2.02 GENERAL

- A. Motor controllers shall be of the combination type complete with integral fused disconnect switch, magnetic-only type circuit breaker (MCP) or thermal magnetic circuit breaker as indicated on the Drawings with integral overload protection. Enclosure rating shall be as indicated on the Drawings or as required by the NEC.
- B. Motor controllers specified herein shall be suitable for use with voltage and phasing as indicated on the Drawings.
- C. Starters and contactors shall be NEMA rated, minimum size 1.
- D. Motor controllers shall be equipped with individual, encapsulated, fused (primary and secondary) control power transformers, unless indicated otherwise on the drawings or herein. Control voltage shall be 120VAC unless indicated otherwise.
- E. Overload protection shall be of the electronic type. A pushbutton shall be provided to manually reset the overload protection with the controller enclosure door closed (automatic reset is not acceptable). The overload protection shall be equipped with a minimum of one normally open and one normally closed auxiliary contact.
- F. Motor controllers shall have an externally operated handle to open the disconnecting means. The handle shall have means to be locked in the open position with a minimum of three standard padlocks.
- G. All equipment furnished shall be new and of current design. Like equipment shall be of the same manufacturer.
- H. Access doors shall be mechanically interlocked with the overcurrent/disconnect device to prevent unintentional opening of the door while energized and unintentional application of power while door is open. Provisions shall be provided for releasing the interlock for intentional access and application of power.

2.03 FULL VOLTAGE NON-REVERSING TYPE

- A. Magnetic controllers shall be equipped with double-break, silver alloy contacts. Controller shall have straight-through wiring.
- B. Operating coils shall be of molded construction through NEMA size 8. All coils shall be color coded through size 5 and permanently marked with voltage, frequency and part number.
- C. Starters and contactors shall be suitable for the addition of at least three external auxiliary contacts of any arrangement of normally open or normally closed.

- D. Motor starters shall be furnished with control features as indicated on the Drawings and as necessary to meet the intent of the Contract Documents. Enclosure ratings shall be as indicated on the Drawings or as required by the NEC.

2.04 NAMEPLATES

- A. Each motor controller shall be furnished with a nameplate identifying the load being served as indicated on the Single Line Diagram. Size shall be 1" x 3" minimum. See Section 16195 for additional requirements.

2.05 CONTROL DEVICES

- A. Provide control devices and components as necessary to meet the intent of design as indicated on the Drawings and described herein.
- B. Operator control devices and pilot lights shall be heavy-duty, oiltight, 30mm. Pilot lights shall be push-to-test, LED style with LED and lens color as indicated on the Drawings. Each operator control device and pilot light shall include an engraved device legend plate, unless the amount of text required exceeds the maximum allowable on a legend plate. If more text is required than allowable, a nameplate per Specification Section 16195 shall be installed. Start pushbuttons shall have green caps, stop pushbuttons shall have red caps, and emergency stop buttons shall be of the push-pull type and shall have red mushroom type caps. All other button caps and selector switch operator handles shall be black.
- C. Terminal blocks shall be furnished and installed for all field-wiring connections. Terminal blocks shall be rated 30A at 600VAC and mount on a standard 35mm din rail. Each terminal block shall be clearly marked with a terminal block designation per approved wiring diagram. Provide a minimum 25 percent spare terminal blocks.
- D. Control/timing relays shall be of the plug-in style with 120VAC, 10A contacts (DPDT minimum) with On-Off indicator. Standard DPDT control and timing relays shall be interchangeable without changing any wiring. Control relays shall have an LED that is illuminated when the control relay is energized. Timing relays shall have an LED that flashes when the relay is timing.
- E. Intrinsically safe relays shall be furnished and installed where indicated on the Drawings or as required by code.
- F. Time clocks shall be electromechanical, 24-hour time switches with 16-hour spring-wound reserve power in NEMA 1 steel enclosures and with 1 ON and 1 OFF trippers. A manual ON/OFF switch shall also be included in the time clock that allows the circuit to be operated without disturbing schedule settings. Time clocks shall be model T173CR as manufactured by Intermatic, or equal.

2.06 ELAPSED TIME METERS

- A. Elapsed time meters shall be non-resettable type, shall read to a maximum of 99999.9 hours, and shall operate when 120VAC is applied. Meters shall contain a bezel for panel mounting with a NEMA 4 rating.

- B. Acceptable manufacturers:
 - 1. Cramer Model 635G
 - 2. Yokogawa Model 240 611 AAAD
 - 3. Or equal

2.07 SPARE PARTS

- A. Provide the following spare parts in addition to those listed above:
 - 1. Two sets of fuses for each size and type used.
 - 2. Two spare pilot light lamps.
 - 3. One spare control and timing relay of each type utilized.
 - 4. One control power transformer of each size used.
- B. Package spare parts in suitable containers bearing labels that clearly indicate the contents. Spare parts shall be stored in a warm, dry location until delivered to the Owner at the end of the project.

PART 3 -- EXECUTION

3.01 CONTROLLER FABRICATION

- A. Motor controllers shall be assembled by the MCC manufacturer or by an approved UL 508A panel fabricator. The entire motor controller or motor control assembly shall be provided with a serialized UL 508A label.
- B. Motor control schematics indicated on the Drawings are schematic only. They are provided for bidding purposes to show the intent of control and operation. They are not intended to be actual wiring diagrams. It is the Contractor's responsibility to ensure that all motor controllers are designed and fabricated properly to meet the intent of the Contract Documents.
- C. Control wiring shall be type MTW with red insulation (#12 minimum for power, #14 minimum for control). All control wiring shall be contained in plastic wireways with removable covers. Wiring to door mounted devices shall be wrapped in a protective plastic flex. Control wiring installed on enclosure doors shall be secured to door with wire anchors cemented in place. Each control wire shall be clearly identified with a shrink-on wire marker and wire number designation per approved wiring diagrams.
- D. All control wiring shall have heat shrinkable wire markers installed near end of wire as specified elsewhere.
- E. All field wiring shall be terminated on terminal blocks within the motor controller.
- F. All door mounted devices and internal control components shall be labeled to match the approved shop diagrams.
- G. All door mounted operator control devices shall be mounted a minimum of 60" above the finished grade level.

- H. All enclosure doors with 120VAC mounted devices shall be bonded to the enclosure ground bus.
- I. Specialty devices not provided by the motor controller assembler shall be provided to the assembler for their installation into the motor controller. Field mounted devices in the motor controller are unacceptable.

3.02 INSTALLATION

- A. Furnish and install all motor controllers as indicated on the Drawings in accordance with the NEC and all applicable industry standards.
- B. Prior to installing motor controllers, coordinate with other trades to verify conduits have adequate space to leave and enter the enclosure and for required code clearance. A minimum working clearance as defined by the NEC 110-26 shall be provided.
- C. Install ductwork between the inner and outer enclosures of NEMA 3R switchgear for exhaust and intake air if cooling is indicated on the Drawings or when cooling fans are required by the controller manufacturer. Openings in the exterior wall of switchgear shall be covered with a metal louver. Air intake louvers shall include a replaceable filter.
- D. Field-test all motor controllers to demonstrate proper operation. The motor controller fabricator shall be present during startup, testing and commissioning of each motor controller. The Engineer and/or Owner shall witness all motor controller field-testing.
- E. Set overload relays per motor manufacturer's recommendations.
- F. The motor protection relay settings shall be initially set as follows (field adjustments may be necessary):
 - 1. Low Voltage: 90% of rated motor voltage
 - 2. High Voltage: 110% of rated motor voltage
 - 3. Voltage Unbalance: 5%
 - 4. Overcurrent: Motor nameplate service factor amps
 - 5. Undercurrent: 80% of motor full load amps
 - 6. Trip Class: As recommended by motor manufacturer
 - 7. Restart Delay Adjustment: 10 seconds
 - 8. Rapid Cycle Timer: Off
 - 9. Trip Delay Adjustment: 2 seconds
 - 10. Successive Restart Attempts: 1

****END OF SECTION****

SECTION 16500

LIGHTING

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Luminaires and lamps.

1.02 SUBMITTALS

- A. Submit manufacturer's data for the following:
1. Luminaires with designation as indicated on the Drawings.
 2. Lamps (type, color, wattage, etc.).
- B. Submit manufacturer's data demonstrating compliance with Specifications and the luminaires as indicated on the Drawings.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (see Section 16010):
1. UL listed and labeled.
 2. NEMA
 3. NFPA 70 (NEC)
 4. IES

PART 2 -- PRODUCTS

2.01 MATERIALS

- A. Luminaires shall be:
1. Furnished with proper outlet boxes, hardware, supports, canopy extensions, etc.
 2. Furnished complete with gaskets, cast aluminum weatherproof outlet box, UL Listed for wet locations, have lamp bases coated with an inhibitor to prevent base from corroding to the socket and be solidly grounded.
 3. Furnished complete with lamps with wattage and voltage as indicated on the Drawings.
 4. Furnished with specified finish and color.
- B. Lamps:
1. LED's and their driver shall be designed for minimum operational life of 50,000 hours in -20°C to 40°C ambient air temperature. The lumen output shall not decrease by more than 20% over the operational life. The driver shall decrease output power when the ambient air temperature is outside the -20°C - 40°C range instead of shutting the LED's off. The driver shall be UL listed and include a quick disconnect plug for maintenance. Kelvin temperature shall be 4000K unless otherwise indicated on the Drawings.

PART 3 -- EXECUTION

3.01 INTERFERENCES

- A. Contractor shall carefully examine the complete areas as well as each individual room where luminaires are to be installed, for interference with piping and other trades. Where such interferences occur, provide luminaires with proper type suspension to overcome such interferences.

3.02 INSTALLATION

- A. Luminaires shall be installed parallel with walls and ground for a neat appearance. Where luminaires are indicated to be mounted on a perimeter wall, luminaires shall be installed on a flush mounted box at an elevation such that the top of fixture is flush with the top of wall.
- B. Operate luminaires after installation and connection. Check for proper operation. Replace luminaires that have failed or are not functional.

3.03 OPERATION

- A. Wall mounted luminaires shall be controlled by a light switch located on the enclosure wall as indicated on the Drawings.

****END OF SECTION****

**PINON WWTP
UPGRADE
ELECTRICAL SPECIFICATIONS
TABLE OF CONTENTS**

16010..... Basic Electrical Requirements

16110..... Raceways

16120..... Wires and Cables (600V or Less)

16130..... Boxes

16140..... Wiring Devices

16195..... Electrical Identification

16250..... Diesel Engine Generators

16260..... Automatic Transfer Switch

16401..... Service Entrance Section

16450..... Grounding

16470..... Panelboards

16475..... Overcurrent Protective Devices

16480..... Mini Power Centers

16500..... Lighting



SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Electrical general provisions as indicated, specified and required for constructing a complete, ready for use electrical system as described in these Contract Documents.
- B. Labor, materials, apparatus, and appliances essential to the complete functioning of systems described and indicated herein, or which may be reasonably implied as essential, whether mentioned in the Contract Documents or not, shall be furnished and installed by the Contractor. In case of doubt as to the work intended, or in the event of need for explanation thereof, Contractor shall refer to the Engineer for supplemental instructions.
- C. All items not specifically mentioned in these Specifications or noted on the Drawings, or on shop drawings, but which are necessary to make a complete and satisfactory, working electrical/instrumentation installation, shall be deemed to be included herein.
- D. All electrical equipment shall be capable of operating successfully at full-rated load, without failure, at an ambient air temperature of -30°C to 50°C, and specifically rated for an altitude of 6320 feet. Where these criteria cannot be met, ancillary equipment and/or special derating factors as approved by the Engineer shall be utilized.
- E. The Contractor shall perform all necessary saw cutting, core drilling, excavating, removal, shoring, backfilling, etc as required for the proper installation of conduits whether inside or outside of the building(s) and structure(s). The Contractor shall repair and patch where demolition has taken place in a manner to match existing original structure.
- F. Since this facility is in continuous operation, the Contractor shall prepare and submit a flow chart and/or written narrative describing the sequence of construction with duration of anticipated power interruptions.

1.02 SUBMITTALS

- A. Submit documentation for review as described in individual Specification Sections for products requiring submission.
- B. Submit Division 16 in one submittal, or at a maximum, the following may be submitted as separate submittals for this project.
 - 1. Commodities (Sections 16010-16195) and Grounding (Section 16450)
 - 2. Standby Generator (16250)
- C. Documentation must be arranged in numerical sequence corresponding with each Specification Section and article of each Section. Soft copies shall be in “pdf”

format with “character recognition” and shall include the following as a minimum:

1. A cover sheet to identify the Contractor’s name, name of the project, date and description, i.e. “Division 16 – Commodities”.
 2. An index corresponding to each specification section with all addendum updates included. Each paragraph or bulleted item shall be check marked to signify compliance with each item and the information is included in the submittal package. If full compliance is not met for any reason, the non-compliance item shall be underlined and reference to a detailed written explanation of the deviation or non-compliance shall be provided in the margin to the right of the specification paragraph or bulleted item for consideration.
 3. Bookmarks within each section for each major component within.
 4. Complete manufacturer name and model number of each item. Listing items “as specified” without both make and model or type designation is not acceptable.
 5. Descriptive Data: complete description, information, and performance data covering materials and equipment that are being proposed. Each component shall be clearly identified on each sheet. Refer to individual specification sections for additional submittal requirements.
- D. If hard copies are provided, they shall be bound in 3-ring binders (2” max) and include all information as described above for soft copies. The binders shall include tabs corresponding to a neatly typewritten index. The binder cover and edge shall clearly identify the Contractor’s name, name of the project, date and submittal number.
- E. Important Notice:
1. **After material or equipment has been submitted and approved, no substitutions will be allowed. Any equipment installed that is different than the approved shop drawings and submittals will be removed and replaced at the Contractor’s expense without exception!**
 2. If Contractor's submittal(s) depart from the Contract Documents, the Contractor shall make specific mention thereof in his letter(s) of transmittal, otherwise review of such submittals by the Engineer shall not constitute review of such departure(s).
 3. The Contractor may be charged for costs incurred by the Engineer for third and subsequent submittal reviews. Cost for Engineer’s review time shall be billed at the Engineer’s standard hourly rates.
- F. For control panels, motor starters and other equipment requiring multiple terminations of components and devices, the Contractor shall submit detailed shop drawings consisting of point-to-point wiring diagrams, bill of materials, interior and exterior elevations with dimensions prepared by the equipment manufacturer or a UL 508A recognized system integrator.

1.03 RECORD DRAWINGS AND OPERATION AND MAINTENANCE MANUALS

- A. Record Drawings: On completion of work, Contractor shall furnish a complete set of Record Drawings and Shop Drawings which properly reflect final locations and sizes of conduit, equipment fixtures, controls, etc., as actually installed. Dimensions shall be included on the Contractor's as-built Drawings showing exact location of underground conduits.
- B. Operation and Maintenance (O&M) Manuals: Contractor shall provide O&M manuals for the standby generators and automatic transfer switches furnished under this contract. O&M manuals must be submitted and approved before final inspection of the project so that they may be used during startup. Soft copies shall be in "pdf" format with "character recognition" and shall include the following as a minimum:
 - 1. A cover sheet to identify the Contractor's name, name of the project, date and description, i.e. "Electrical Equipment O&M Manual".
 - 2. Bookmarks within each section for each major component within.
 - 3. Complete manufacturer name and model number of each item.
 - 4. Descriptive data, wiring diagrams, dimensional drawings, etc from the approved submittals/shop drawings.
 - 5. Complete instructions regarding the installation, operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
 - 6. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or components not related to equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
 - 7. Copy of warranties issued on the installation, showing dates of expiration.
- C. Hard copies, if provided, shall be bound in 3-ring binders (2" max) and include all information as described above for soft copies. The binders shall include tabs corresponding to a neatly typewritten index. The binder cover and edge shall clearly identify the Contractor's name, name of the project, date and identified as "Electrical Equipment O&M Manual".

1.04 QUALITY ASSURANCE

- A. The Contractor performing the electrical construction and installation shall be a reputable Contractor licensed in the State of Arizona to do electrical **commercial** construction. As a minimum, an "L-11 Commercial" license is required. If any electrical work over 600V is required, the Contractor must also be licensed to work on High Voltage Electrical and Transmission Lines.
- B. The Contractor must be located within a 400-mile radius of the project and have been in that vicinity for a minimum of five (5) years.

- C. The Contractor must have a minimum of five (5) years experience as a Contractor installing electrical systems for other water and wastewater projects of similar type, size and requirements. If requested, the Contractor must submit documentation and list of references of recent projects similar to this one.
- D. All equipment furnished shall be new and of current design. Like equipment shall be of the same manufacturer.
- E. Unless otherwise indicated, all equipment and components shall be rated for use in the environment installed. Outdoor equipment shall be weatherproof or rated for outdoor use.

1.05 SPACE REQUIREMENTS

- A. Space Requirements: In the preparation of Drawings, a reasonable effort has been made to include equipment manufacturer's recommendations. Since space requirements and equipment arrangement vary according to manufacturer, the responsibility for initial access and proper fit rests with the Contractor. Final arrangement of equipment and service connections shall allow the unit to be serviced, including space to pull motors, change fuses, and operate switches. Minimum working clearances shall be as required by NEC and local codes.

1.06 COORDINATION

- A. Contractor shall coordinate with all other trades to avoid conflicts and interferences. No extra compensation will be allowed for changes made necessary due to interference between work of various trades.
- B. Any discrepancies noted in these contract documents or discrepancies between Drawings and actual field conditions shall be promptly brought to the Engineer for a decision. No extra compensation will be allowed for changes made by the Contractor without Engineer's consent.
- C. Carefully check and coordinate each device location and elevation. Also check routing of all conduits for conflicts with structures, mechanical piping, ducts, etc. to avoid conflicts.

1.07 REGULATORY REQUIREMENTS

- A. Electrical work, including connection to electrical equipment integral with mechanical equipment, shall be performed in accordance with the latest published regulations of the National Electrical Code (NEC), State and local codes, and according to the latest Institute of Electrical and Electronic Engineers (IEEE); American National Standards Institute (ANSI); American Society for Testing and Materials (ASTM); Insulated Cable Engineers Association (ICEA); National Electrical Manufacturers Association (NEMA) Standards; and the latest published regulations of the Federal Occupational Safety and Health Act (OSHA). When applicable, the material used in the performance of the electrical work shall be listed by the Underwriters' Laboratories, Inc. (UL) for the class of service for which they are intended.

- B. Control panels shall be assembled and wired by a UL 508A recognized panel shop. All control panel components shall be UL recognized or ground fault protected per UL 508A fabrication standards. Each control panel assembly shall be fabricated according to UL 508A Standards and shall bear a serialized UL 508A label.

1.08 WARRANTY

- A. In addition to specific warranties required by the Specifications, the Contractor shall leave the entire installation in complete working order and free from defects in materials, workmanship or finish. Contractor shall repair or replace at his own expense any part that may develop defects due to faulty material or workmanship during the tests and within a period of one year after the work is accepted by the Engineer and Owner. Contractor shall repair or replace existing equipment and work that is damaged during the repair of defective apparatus, materials or workmanship.
- B. All manufacturer's warranties shall be filled out in their entirety by the Contractor for the Owner using the Owner's name and address. Unless otherwise specified, equipment warranty periods will commence on date of final acceptance.

1.09 DRAWINGS

- A. **Clarity and Legibility:** For purposes of clarity and legibility, the Drawings are diagrammatic only. Drawings are not intended to show every fitting, junction, gasket or component necessary, nor every difficulty that may be encountered during installation. Conduit routing may be adjusted in the field. Size and location of equipment are drawn to scale wherever possible. Contractor shall refer to related data in all Contract Documents and shall verify this information on site.
- B. Schematic diagrams are provided to indicate the control strategy intent only. Final circuitry shall be as determined by the Contractor or his vendors. Actual wiring diagrams shall be provided by the Contractor and reviewed by the Engineer for a fully functional system as intended.

1.10 REFERENCES

- A. The specifications reference known standards and codes. Each such standard referred to shall be considered a part of the Specifications to the same extent as if reproduced therein in full. The following is a representative list of such Associations, Institutes and Societies, together with the acronym by which each is identified.

AASHTO	American Assoc of State Highway and Transportation Officials
AIEE	American Institute of Electrical Engineers
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IES	Illumination Engineering Society

NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NETA	National Electrical Testing Association
NFPA	National Fire Protection Association
NTUA	Navajo Tribal Utility Authority
UL	Underwriter's Laboratories, Inc.

- B. Every reference in the Specifications shall mean the latest printed edition of each in effect at the Contract Date.

1.11 UTILITY SERVICE

- A. Contractor shall contact NTUA to provide or remove electrical service(s) to the site. This includes the permanent as well as any temporary service requirements. The Contractor shall provide all necessary labor and material required to obtain this service(s) in accordance with utility requirements. Any utility company fees and charges associated with providing, maintaining and usage of these services shall be paid by Owner.
- B. Submit copies of electrical service entrance equipment to NTUA for approval prior to releasing switchgear for fabrication. A copy of this approval letter shall be submitted to the Engineer.

1.12 ABBREVIATIONS

- A. References on the Drawings to various abbreviations have been made. The following is a representative list of such abbreviations together with the acronym by which each is identified.

AFF	Above finished floor
AFG	Above finished grade
AI	Analog input
AO	Analog output
ATS	Automatic transfer switch
C	Conduit
C/B	Circuit Breaker
CKT	Circuit
CPT	Control power transformer
Cu	Copper
DI	Digital input
DIST	Distribution
DO	Digital output
DWG	Drawing
GND	Ground
GFCI	Ground Fault Circuit Interrupter
GFI/GFP	Ground Fault Indication/Protection
GRS	Galvanized Rigid Steel Conduit
HPS	High Pressure Sodium
IMC	Intermediate Metal Conduit
INST	Instrument

LED	Light Emitting Diode
MBJ	Main bonding jumper
MCB	Main Circuit breaker
MCC	Motor Control Center
MCP	Motor Circuit Protector
MFR	Manufacturer
MLO	Main Lug Only
NC	Normally Closed
NO	Normally Open
NTUA	Navajo Tribal Utility Authority
PC	Personal computer
PLC	Programmable logic controller
PR	Pair
REQ'TS	Requirements
RTU	Remote terminal unit
SES	Service entrance section
SPD	Surge Protective Device
RMC	Rigid Metal Conduit (GRS or IMC)
RVSS	Reduced Voltage Soft Starter
SWBD	Switchboard
TSP	Twisted Shielded Pair
TST	Twisted Shielded Triad
VFD	Variable frequency drive
WP	Weatherproof

****END OF SECTION****

SECTION 16110

RACEWAYS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Metallic and non-metallic wiring raceways.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data demonstrating compliance with this specification including couplings, fittings, bushings, and hangers.
- B. Submit on the proposed method for separating conduits in underground ductbanks.

1.03 QUALITY ASSURANCE

- A. Perform work in accordance with NECA Standard of Installation and NFPA 70.

1.04 RELATED WORK

- A. Specification Section 16195, Electrical Identification

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Conduit:
 - 1. Rigid metal, intermediate and EMT:
 - a. Allied
 - b. Republic
 - c. Triangle Conduit and Cable Co.
 - d. Wheatland
 - 2. PVC coated rigid steel:
 - a. Ocal
 - b. Robroy
 - c. Calbond
 - d. Gafco Green
 - 3. Flexible and flexible water-tight:
 - a. Alflex Corp.
 - b. Carlon Products Corp.
 - c. Carol Cable Co., Inc.
 - d. Electri-Flex
 - e. Sealtite
 - 4. Non-metallic PVC:
 - a. Can-Tex

- b. Carlon
- c. PW Eagle/JM Eagle
- 5. Conduit supports and hangers:
 - a. Caddy
 - b. Thomas and Betts
 - c. Appleton
 - d. Crouse-Hinds
 - e. B-Line Systems
- 6. Supporting Channel:
 - a. G-Strut
 - b. Unistrut
 - c. B-Line

2.02 MATERIALS

- A. Metallic Conduit:
 - 1. Rigid steel:
 - a. Hot dipped galvanized rigid steel; meet ANSI C80.1 and ASTM A153; UL labeled and meet UL Standard No. 6.
 - b. All fittings shall be threaded. Threadless couplings shall not be used unless specifically approved by the Engineer.
 - c. All conduit body covers shall be secured with machine screws threaded onto the conduit body. Covers secured by snaptight or wedge-nuts are unacceptable.
 - d. Where PVC coated rigid steel conduit is indicated on the Drawings, the conduit shall be galvanized steel with a factory installed PVC coating. All conduit fitting, boxes, connectors, etc. shall also be PVC coated by the factory.
 - e. No aluminum conduit shall be permitted unless approved by the Engineer.
 - 2. Intermediate: Shall be same as rigid above with thinner wall.
 - 3. Electrical metallic tubing (EMT or Thin-wall) shall be:
 - a. Galvanized; meet ANSI C80.3; UL labeled; marked with manufacturer's name.
 - b. Thin-wall conduit fittings for damp or wet locations shall be of the regular watertight design, with hexagonal nuts and center portions requiring the use of a wrench during installation.
 - c. Setscrew type fittings are not permitted under any circumstances.
 - 4. Flexible conduit:
 - a. UL-listed flexible rubber or plastic coated metallic type with watertight ferrule and sleeve type connectors. Standard steel type flexible conduit is unacceptable.

- b. ANSI/NEMA FB1 steel connectors. Connectors must be PVC coated where installed in corrosive environments or where PVC conduit or PVC coated GRS conduit is specified.
 - c. Flexible conduit installed in hazardous classified areas shall be explosion-proof or be rated for use in the specified area classification.
- B. Non-Metallic PVC Conduit:
- 1. Rigid non-metallic conduit Polyvinyl Chloride (PVC) type II PVC shall be schedule 40, suitable for use with 90 degree rated wire. Conduit shall bear UL labels for above and below ground use.
 - 2. All PVC conduit 1-1/4 inch and larger with bends greater than 45° shall utilize factory bends.
 - 3. Where the enclosure or raceway is subject to physical damage, conductors shall be installed in rigid metal conduit, intermediate metal conduit, Schedule 80 rigid nonmetallic conduit or equivalent.
 - 4. Meet UL standard #651.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. General:
- 1. Raceways shall be concealed, where possible, unless otherwise indicated on the Drawings. When exposed, confirm the exact routing with the Engineer prior to roughing in.
 - 2. Sizing: Minimum conduit sizes are indicated on the Drawings. The Contractor may choose to install larger conduit for ease of installation or wiring pulling at no additional cost to the Owner. If conduit or raceway size is not indicated on the Drawings, raceways shall be sized per NEC. Unless otherwise indicated, minimum conduit size shall be 3/4 - inches.
 - 3. Unless otherwise indicated, all exposed conduits shall be galvanized steel rigid metal conduit (RMC) or intermediate metal conduit (IMC). All direct buried or concrete encased conduits to be Schedule 40 PVC.
- B. Conduit:
- 1. Conduit shall: Have openings temporarily plugged, using “pennies” or equal, to exclude plaster or other foreign materials; be reamed after cutting; have joints cut square, and butt solidly into fittings; have the ends terminated in a proper bushed fitting, be rigidly supported so as to prevent undue stress or strain on the couplings and connectors; be swabbed before conductors are pulled in.
 - 2. Concealed conduits shall be run in a direct line with long sweep bends and offsets. Horizontal runs shall be run with a slight incline, to prevent low spots or pockets (for drainage).

3. Conduits shall be continuous from outlet to outlet, from outlets to cabinets, pull or junction boxes and shall be secured to boxes with lock nuts and bushings in such a manner that each system shall be electrically continuous throughout. “Erickson” couplings shall be used where required. No running threads shall be cut.
4. Install conduit systems completely before conductors are pulled. Conduits shall be securely supported at proper intervals to structures with steel clamps, or conduit hangers or by special supporting assemblies when indicated on the Drawings.
5. Conduit terminations shall contain insulated bushings. Provide grounding type bushings where steel conduit is stubbed into nonmetallic enclosures, stubbed up in the base of freestanding enclosures or where locknuts cannot assure proper ground continuity between metallic enclosures and the steel conduit. Provide service entrance and transformer connection conduits with grounding type bushings.
6. Exposed conduits shall be installed parallel to walls, floor and ceilings or at right angles to the building lines. Exposed bends shall be used only where approved. Covers shall be secured to bodies with machine screws.
7. Electrical metallic tubing (EMT) or “Thin-wall” may not be used except where specifically indicated on the Drawings or as directed by the Engineer.
8. Hickey bends shall not be used for 1-inch and larger conduits. Either manufactured elbows or bends fabricated in a bending machine shall be used. The radius of the inner edge of bends shall be six times the internal diameter of the conduit for conduit sizes up to 2 ½-inches and 12 times internal diameter for 3-inches conduits and larger. A run of conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than 360° of total bends.
9. Conduit shall not be run above or below water piping, and must be individually supported.
10. In wet locations, and in locations where walls are frequently washed, the entire conduit system, including boxes and fittings used, shall be installed and equipped to prevent water from entering conduit. Conduit shall be so mounted so that there is at least ¼-inch air space between conduit and wall or similar supporting surface.
11. Schedule 40 PVC conduit may be used for buried conduit installations as permitted by the NEC and local codes except where galvanized rigid steel is specified. Couplings, transition fittings, adhesives, primer and installation procedures recommended by the conduit manufacturer and all applicable codes must be strictly followed.
12. Install liquid-tight flexible metal conduit at motors, transformers and equipment which are subject to vibration or require movement for maintenance purposes. Provide necessary reducer where equipment

furnished cannot accept 3/4-inch size flexible conduit. Limit flexible conduit length to 3-foot maximum.

- C. Sleeves, Inserts, etc.: Lay out and install work in advance of the laying or pouring of floors and erection of walls. Furnish and install sleeves that may be required for openings through floors, wall, etc. Where plans call for conduit to be run exposed, furnish and install inserts and clamps for the supporting of conduit. If this Contractor does not properly install sleeves and inserts required, he will be required to do the necessary cutting and patching later, at his own expense, to the satisfaction of the Engineer.
- D. Installation of Underground Conduits:
1. Install underground conduit as indicated on the Drawings. Backfill material around the conduits must be clean-fill (dirt with rocks no larger than 1/2-inch).
 2. Conduit bends shall have long sweep radius curves instead of standard elbows where indicated on the Drawings. All PVC conduit bends greater than 45° shall be factory-made for conduits larger than 1-inch.
 3. All underground PVC conduit shall be buried a minimum of 24-inches below finished grade, except when located below a concrete slab or freestanding electrical equipment. Conduit shall be installed deeper than 24-inches wherever required to avoid existing piping, tunnels, or other obstructions.
 4. Underground conduits in ductbanks shall be separated and supported with pre-manufactured plastic chairs, unless submitted and approved otherwise, installed at 5-foot intervals in the trench.
 5. ***After duct is in place, notify the Engineer prior to backfill for inspection.*** Failure to do so will result in removal of all backfill material to expose the conduits for inspection.
 6. During backfill, provide plastic warning tape at 12-inches below finished grade over underground electrical installations which reads, "Caution - Buried Electrical Line Below".
 7. Any portion of the conduit with less than 24-inches of cover shall be PVC coated rigid metal conduit or galvanized rigid metal conduit wrapped with 20-mil rubber tape half-lapped to a thickness of 40-mils. PVC conduits are permitted to be stubbed up directly into freestanding electrical enclosures.
 8. Where terminating PVC conduit in a freestanding enclosure, underground junction box, manhole/handhole or other similar locations, provide each termination with a bell end.
 9. Rigid metal conduit terminations shall contain insulated bushings. Provide grounding type bushings where steel conduit is stubbed into nonmetallic enclosures, stubbed up in the base of freestanding enclosures or where locknuts cannot assure proper ground continuity between metallic enclosures and the steel conduit. Install grounding type bushings on all service entrance and utility transformer connection conduits.

10. Spare conduits shall be capped with an approved plug.
11. Before pulling cables into underground conduits, pull a mandrel ¼-inch smaller than the conduit inside diameter and pulled through each conduit, and if any concrete or obstructions are found, the Contractor shall remove them and clear the conduits. Underground conduits shall be swabbed before cables are pulled in.
12. After duct runs are completed and set, backfill the trenches and tamp thoroughly to 90 percent compaction.

3.02 CONDUIT MARKERS

- A. All conduits with conduit designations indicated on the Drawings shall be identified at each termination. See Section 16195 - Electrical Identification for conduit tag requirements.

****END OF SECTION****

SECTION 16120
WIRES AND CABLES
(600V OR LESS)

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Cables and wires rated 600 volts or less, as specified, including wiring of all devices.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data on all power, signal and communication cables demonstrating compliance with this Specification.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards:
 - 1. NFPA 70 (NEC)
 - 2. UL listing for materials.
 - 3. ICEA S-66-524
 - 4. NEMA WC-7
 - 5. ASTM B-3 or B-8

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Cable:
 - 1. General Cable
 - 2. Okonite
 - 3. Southwire
 - 4. Encore
- B. Connectors:
 - 1. Ideal
 - 2. Burndy Corp.
 - 3. Thomas and Betts Co.
 - 4. O.Z. Gedney
 - 5. Minnesota Mining & Manufacturing (3M)

2.02 MATERIALS

- A. Conductors for wire and cable shall be stranded copper with 98 percent conductivity and shall be tinned or untinned in accordance with established standards for the type of insulation around the conductors. Solid conductors are not acceptable.

- B. Wire and cable shall be stamped approximately every two feet to indicate voltage, type, temperature rating, and other significant data or warnings.
- C. Conductors for general purpose wiring shall meet the following requirements:
 - 1. Power: Type XHHW-2. Minimum conductor size for power shall be No.12 AWG.
 - 2. Control: Type XHHW-2 for conductors run in conduit, minimum size No.14 AWG. Type MTW for conductors contained in control panels, minimum size No.14 AWG or No.16 AWG when protected by an overcurrent device of 10A or less.
- D. Wire Pulling Lubricant: Lubricant shall be UL listed and be of a consistency that will not leave an obstruction or tackiness that prevents pulling out wires in the future. No soap flakes or vegetable soaps will be permitted. Lubricant in shall be Ideal Wire Lube or equal.
- E. Cable Ties: Wiring in panels, cabinets, etc. shall be neat and tied with “Ty-Rap” T&B “TY-5418” series, or Panduit Co. “Cable Wrap”. Cable ties used in outdoor locations shall be UV stabilized.
- F. Terminations:
 - 1. 3-M Scotchlok lugs and connectors - copper.
 - 2. O-Z solderless connectors, grounding devices, power connectors, armored cable fittings, and cable terminations.
 - 3. Burndy - copper - all types as appropriate for cable size and configuration.
- G. Connector material shall be compatible with conductor material to prevent corroding, differences in coefficients of expansion or electrolysis.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Install wires and cables in NEC approved raceways (Section 16110). All wire and cable must be installed in a raceway, unless otherwise indicated on the Drawings.
- B. Branch circuit and feeder conductors shall have insulation with the following color. Phase tape is unacceptable.
 - 1. Grounding conductor-Green.
 - 2. Neutral - White.
 - 3. 120/240V Phase A - Black.
 - 4. 120/240V Phase B - Red.
 - 5. 120/208V Phase A - Black.
 - 6. 120/208V Phase B - Red.
 - 7. 120/208V Phase C - Blue.
 - 8. 277/480V Phase A - Brown.
 - 9. 277/480V Phase B - Orange.
 - 10. 277/480V Phase C - Yellow.

- C. 6-inch minimum loops shall be provided at each outlet, device or luminaire. Unused wires in outlet boxes, shall be rolled up, connected together and taped or capped with wire nuts. Mark bundled, unused spare wires as “SPARE FROM [origination]”.
- D. Branch circuit sizing: Where wire size is not indicated on the Drawings, NEC and local codes shall govern. However, minimum branch circuit conductor size shall be No. 12 AWG.
- E. Pulling Cables: Wires and cables shall be carefully handled during installation. Lubricant used for pulling in wires and cables shall be used. Use a dynamometer when pulling conductors by mechanical means.
- F. Bending radius: Do not exceed the manufacturer’s maximum bending radius.

3.02 SPLICES AND TERMINATIONS

- A. Splices:
 - 1. Splices in conductors shall not be used unless otherwise indicated on the Drawings or approved by the Engineer.
 - 2. Where splices are allowed or necessary, they shall be mechanically strong and well made so that the electrical resistance of a joint shall not exceed that of 2-feet of the conductor.
 - 3. Splices shall be made only in junction boxes and never in conduit.
 - 4. Above Grade Splices:
 - a. Utilize wing nut solderless connectors for splicing No. 8 AWG and smaller conductors. Follow manufacturer’s recommendations for sizing, stripping, twisting, etc.
 - b. Utilize insulated butt connectors crimped end-to-end for splicing No. 6 AWG and larger conductors. Follow manufacturer’s recommendations for sizing, stripping and crimping.
 - 5. Below Grade Splices:
 - a. Utilize waterproof splice kits or wing nut solderless connectors with cast-resin waterproofing for splicing No. 8 AWG and smaller conductors. Follow manufacturer’s recommendations for sizing, stripping, twisting, etc.
 - b. Utilize insulated butt connectors crimped end-to-end with cast-resin waterproofing for splicing No. 6 AWG and larger conductors. Follow manufacturer’s recommendations for sizing, stripping and crimping.
 - c. Utilize insulated butt connectors crimped end-to-end for all below grade splices or No. 6 AWG and larger conductor splices above grade. Follow manufacturer’s recommendations for sizing, stripping and crimping.
- B. Motor terminations: Ring type, crimped connectors shall be installed on all conductors and bolted together back-to-back. For terminations with No.6 and smaller wire, use 10-24 bolts. Use bolts that match the connector bolthole size for

all other motor terminations. Apply one layer of cambric tape followed by three layers of rubber tape and finally, top with one layer of black vinyl tape.

- C. Non-motor terminations: Use ring or fork type, crimped connectors for all screw-on terminations. Wrapping wire around a binding post is unacceptable.
- D. Where special tools are required to properly install the particular connector the special tools must be used.

3.03 WIRE MARKERS

- A. All conductors shall be labeled at each termination and splice. See Section 16195 - Electrical Identification for wire marker requirements.

****END OF SECTION****

SECTION 16130

BOXES

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Outlet boxes, pull and junction boxes and underground junction boxes.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data for standard outlet boxes up to six gang, including floor type demonstrating compliance with specification requirements and Drawings.
- B. Shop Drawings: Submit drawings for special pull, outlet, and junction boxes demonstrating compliance with NEC and specification requirements. Drawings shall indicate box dimensions and locations in building.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards:
 - 1. NEMA 250
 - 2. NFPA 70
 - 3. UL listing for materials.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Appleton Electric
- B. Crouse-Hinds
- C. Killark
- D. Raco
- E. Hoffman Engineering Co.
- F. O.Z. Gedney Co.
- G. Steel City
- H. Hubbell
- I. Rittal

2.02 MATERIALS

- A. Outlet boxes for concealed conduits and flush-mounted wiring devices shall meet the following requirements:

1. Stamped, one piece, galvanized steel.
 2. Proper size and shape for conduits entering them.
 3. UL listed for their application.
 4. ANSI/NEMA OS-1 for galvanized steel; ANSI/NEMA OS-2 for non-metallic.
- B. Outlet boxes for exposed conduit systems and exterior locations shall be of the threaded-hub, cast-metal, conduit type fitting suitable for the wiring devices to be installed. Covers (blank, switch, receptacle, etc.) shall be the type specifically designed to fit the specified boxes.
- C. Above grade electrical junction and pull boxes shall be sheet metal with an ANSI 61 gray color with size and type as indicated on the Drawings. NEMA rating shall be as indicated on the Drawings. Where a NEMA rating is not indicated, outdoor boxes shall be NEMA 3R and indoor boxes shall be NEMA 12. Box sizes shall be as indicated on the Drawings. Where sizes are not indicated or larger size is required to meet code, the box size shall be increased as required by the National Electrical Code.
- D. Wireways:
1. Wireways shall be sized as indicated on the Drawings or as required by the National Electrical Code. Where sizes are not indicated or larger size is required to meet code, the wireway shall be sized such that the cross-sectional area of the wireway at any one point does not exceed 40% per the National Electrical Code.
 2. Cover: Hinged with removable latches where feasible.
 3. UL listed for steel enclosed wireway or auxiliary gutter.
 4. Furnished complete with covers, elbows, tees, junction boxes, end covers, connectors and hangers.
 5. Unless otherwise indicated, wireways shall be NEMA 3R.
 6. Wireways in outdoor locations shall be fully gasketed.
- E. Underground junction boxes:
1. Construction: Electric underground junction boxes shall be precast concrete and size as indicated on the Drawings. Underground junction boxes shall have precast concrete extensions.
 2. Covers: Covers shall be rectangular, reinforced concrete and have the text "ELECTRIC" cast into the cover.
 3. Approved Manufacturer: Christy, or equal.
- F. Fittings, hangers, fastenings, etc., shall be of material that will prevent chemical reaction between itself and conduit or device it is fastening or supporting.

PART 3 -- EXECUTION

3.01 BOX LOCATIONS

- A. Location of Boxes: In order that boxes may be placed in proper locations, the Contractor shall familiarize himself with the details of these spaces and carefully lay out boxes so that the equipment or piping of other trades passing under, over, across or in close proximity to same, will not cause these boxes to be inaccessible for use or maintenance. Contractor shall consult with other Contractors and trades on the project and obtain details of the project to locate outlet boxes properly.
- B. Contractor shall be responsible for the exact and proper location of the various portions of his work. Consult the Drawing and details.
- C. Mounting Heights: The exact mounting height of each switch, receptacle, light fixture outlet, etc., shall be confirmed on the premises in conference with the Engineer. Unless otherwise indicated, receptacles to be mounted at 18-inches and light switches to be mounted at 42-inches above finished floor/grade.

3.02 INSTALLATION

- A. No thru-boxes shall be permitted.
- B. Boxes shall meet the following requirements:
 - 1. Proper size and shape for conduits entering them.
 - 2. Installed so that device and/or cover plates shall be tight and plumb with wall finish.
 - 3. Have unused openings closed with knock-out closures.
 - 4. Securely fastened to building or structure.
- C. Surface-mounted outlet boxes shall meet the following requirements:
 - 1. Outdoor boxes shall be cast steel or cast aluminum with threaded hubs.
 - a. Fastened with not less than two Paine, Phillips, Ackermann-Johnson, or equivalent, screw anchors and round head machine screws on brick and concrete walls or ceilings.
 - b. Under no circumstances will drilling of cast boxes be allowed.
 - c. PVC coated boxes shall be used for installations with PVC coated rigid steel conduit.
 - d. Be provided with a vapor-proof gasket in wet locations or where indicated as "WP" (weatherproof) on the Drawings.
 - e. Install a weatherproof-while-in-use cover on all outdoor receptacles.
 - 2. Bell boxes may be used for indoor applications where rigid steel or IMC conduit is required.
- D. Flush-mounted outlet boxes shall:
 - 1. Be solid ganged boxes for more than two devices.
 - 2. Contain a plaster ring to bring the wiring device attachment points within ¼-inch of the finished wall surface.
 - 3. Be installed so that device covers are tight and plumb with wall finish.

4. Be installed as close as possible to the lock side of door trim for light switches.
- E. Bracket outlets shall be level and centered on columns or above doors when installed in these locations.
- F. Pull boxes and junction boxes shall be:
1. Installed where indicated on the Drawings or where necessary to not exceed 360 degrees of conduit bends.
 2. Entirely accessible.
 3. Securely mounted to building structure independent of the conduits connected to them.

****END OF SECTION****

SECTION 16140
WIRING DEVICES

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Wiring devices such as but not necessarily limited to power receptacles and light switches.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data for each wiring device including device covers demonstrating compliance with these Specifications and UL labeling.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and standards:
 - 1. NEMA
 - 2. UL listing
 - 3. NFPA 70

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Hubbell
- B. Leviton
- C. Bryant
- D. Crouse-Hinds
- E. Pass & Seymour

2.02 MATERIALS

- A. Light switches and receptacles shall meet NEMA WD1 and WD6 standards, be UL listed and be Heavy Duty, **Industrial** Specification grade. Commercial specification grade wiring devices are not acceptable.
- B. Amperage rating of each wiring device shall match the circuit's overcurrent device amperage rating to which it is connected.
- C. Wiring devices shall have an ivory finish unless otherwise specified.
- D. Power receptacles shall be the grounded type. Furnish ground fault circuit interrupter (GFCI) type where indicated on the Drawings or as required by the NEC.
- E. All GFCI receptacles shall be listed weather-resistance (WR) type receptacles.
- F. Light switches shall be the quiet type.

- G. Wiring Device Coverplates:
1. Unless otherwise indicated, coverplates installed indoors or in control panels shall be brushed anodized aluminum.
 2. Weatherproof locations: Wiring devices installed outdoors or where identified on Drawings with “WP” shall contain a gasketed coverplate UL approved for wet locations.
 3. Where weatherproof-while-in-use coverplates are indicated on the Drawings or required by NEC, power receptacles shall be provided with a cover that is listed for “extra duty” and maintains UL approval for wet locations when a cord is plugged into the receptacle.

PART 3 -- EXECUTION

3.01 INSTALLATION/APPLICATION

- A. Devices and coverplates shall be plumb and parallel to adjacent surfaces or trim. Flush-mounted devices must be flush with finished wall surfaces and the coverplates must be tight to surfaces over which they are installed.
- B. Receptacles identified as GFCI or when required by the NEC shall have individual GFCI receptacles installed for each outlet. Installing a single GFCI receptacle and standard receptacles connected to the load side of the single GFCI receptacle is unacceptable.

3.02 FIELD QUALITY CONTROL

- A. Contractor shall verify that the openings have been properly patched around devices without damage to devices.
- B. Damaged or painted devices shall be replaced or cleaned as directed by the Engineer.

****END OF SECTION****

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 -- GENERAL

1.01 SECTION INCLUDES

- A. Nameplates and labels
- B. Wire and cable markers
- C. Conduit markers

1.02 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code.
 - 1. NEC 110-22 Identification of Disconnecting Means
 - 2. NEC 200-6 Means of Identifying Grounded Conductors
 - 3. NEC 200-10 Identification of Terminals
 - 4. NEC 210-5 Identification for Branch Circuits
 - 5. NEC 215-8 Means of Identifying Conductor with the Higher Voltage to Ground
 - 6. NEC 230-70, (B) Service Equipment, Marking
 - 7. NEC 310-11 Marking
 - 8. NEC 310-12 Conductor Identification
 - 9. NEC 400-22 Grounded-Conductor Identification
 - 10. NEC 400-23 Equipment Grounding Conductor Identification
 - 11. NEC 408-13 Panelboard circuit identification
- B. UL standard 224- Standard for Extruded Thermoplastic Insulating Tubing.

1.03 SUBMITTALS

- A. Product Data: Provide catalog data for the following:
 - 1. Wire and cable marking system
 - 2. Nameplate materials and fasteners
 - 3. Conduit markers

1.04 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

PART 2 -- PRODUCTS

2.01 NAMEPLATES AND LABELS

- A. Engraved laminated plastic nameplates with black letters on white background shall be installed on the following as a minimum:
 - 1. Electrical distribution equipment enclosures
 - 2. Disconnect switches and motor controllers
 - 3. Control panels and cabinets
 - 4. Each motor controller or control panel door mounted device
 - 5. Major components, control relays and terminal block strips mounted on the backpanel of control panels
- B. Letter Size:
 - 1. Use 3/8-inch letters for identifying electrical distribution equipment enclosures and other large control panels and cabinets. Use 3/16-inch letters for identifying individual control panel components (inside or out) and small control panels/enclosures.

2.02 WIRE MARKERS

- A. Manufacturer: Raychem Corporation Model ShrinkMark or equal.
- B. Description: heat shrinkable radiation cross-linked, thermally stabilized, modified polyolefin sleeves with 3:1 shrink ratio. Markers shall be UL Standard 224 recognized.
- C. Sleeves shall be smear resistant prior to shrinking and achieve mark permanency when shrunk without the need for permatizing equipment. Sleeves should achieve mark permanency when standard ballpoint pens or high-carbon content fabric ribbons are used. The markers shall be flattened and mounted on a carrier suitable for use with commercially available print equipment. Markers shall be printable on both sides. Markers shall be resistant to common industrial fluids including Freon TF, Isopropyl alcohol, and Ethylene Glycol.
- D. Locations: Each conductor at each termination and splice.
- E. Legend:
 - 1. Power and Lighting Circuits: Branch circuit or feeder number indicated on the Drawings.
 - 2. Control Circuits: Control wire number indicated on approved schematics, interconnection diagrams and shop drawings.
 - 3. Wire numbers shall be the same at both ends of the wire.

2.03 CONDUIT MARKERS

- A. Furnish and install conduit markers on ends of each conduit run and in intermediate locations such as manholes and handholes. Conduit markers shall be 19 gauge, 1 1/2-inch diameter round brass with backfilled legend, Style #250-BL as manufactured by Seton Nameplate Corporation or equal. Marker shall identify conduit as indicated on the Drawings. If a conduit is not identified on the Drawings, the Contractor shall consult the Engineer for the proper identification.

PART 3 -- EXECUTION

3.01 NAMEPLATES

- A. Install nameplates parallel to equipment lines.
- B. Secure nameplates to the exterior of electrical equipment using UL-508A approved die and tapped stainless steel screws (APM SEELSKREW or equal).
- C. Secure nameplate to inside surface or backpanels of control panels with a permanent adhesive (Liquid Nails or equal).

3.02 WIRE MARKERS

- A. Wire markers shall be a minimum of 3/8-inches in length and placed as near as possible to the end of the wire. Orient wire marker such that the writing can be read without turning or twisting the wire.
- B. Wire numbers shall be the same at both ends of the wire.

3.03 CONDUIT MARKERS

- A. Attach markers near the end of exposed conduits with stainless steel tie-wire.
- B. Secure conduit markers to the floor using a permanent epoxy where conduits terminate in bell ends flush with finished floor in freestanding equipment.

****END OF SECTION****

SECTION 16250

DIESEL ENGINE GENERATORS

PART 1 -- GENERAL

1.01 DESCRIPTION:

- A. Section includes furnishing and installing a UL Listed, enclosed outdoor diesel engine-driven standby generators complete with all appurtenances, as indicated on the Drawings and specified herein. The standby generator supplier must be the authorized distributor for the manufacturer of the engine.

1.02 REFERENCE:

- A. STANDARDS:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. AB-1, Molded Case Circuit Breakers.
 - b. ICS, General Standards for Industrial Control and Systems.
 - c. MG-1 1978, Motors and Generators.
 - d. SG3, Low Voltage Power Circuit Breakers.
 - 2. Institute of Electrical & Electronic Engineers (IEEE).
 - 3. Underwriters' Laboratories, Inc. (UL-2200).
 - 4. Diesel Engine Manufacturers Association.
 - 5. National Fire Protection Association (NFPA):
 - a. NFPA-110, Standard for Emergency and Standby Power Systems.
 - 6. American National Standards Institute (ANSI):
 - a. 50.5 Rotating Exciters for Synchronous Machines.
 - b. C50.12 Salient Pole Synchronous Generators and Condensers.
 - 7. Environmental Protection Agency (EPA) 70 FR 39870

1.03 SUBMITTALS:

- A. Submit the following:
 - 1. Manufacturer's specifications, catalog data, descriptive matter, illustrations, diagrams, etc., including but not limited to engine, generator, voltage regulator, fuel tank, batteries, battery charger, exhaust system, water jacket heater, output circuit breaker and generator control panel showing compliance with this Specification Section.
 - 2. Drawings: Outline drawing of each generator set with overall dimensions. Interconnection wiring diagrams of the generator control systems showing control connections between generator, transfer switch and auxiliary equipment. Power and control wiring conduit entrance locations. Fuel lines and connections. Base anchoring footprint drawing. Control panel layout.

3. A certificate acknowledging that the generator set will properly start and run the loads indicated on the Drawings for 16 continuous hours with the installation configuration within the CMU block walls as indicated on the Drawings.
4. Engine generator unit prototype test report of identical size, type and construction. Generator test report shall certify the following:
 - a. Maximum output power
 - b. Maximum motor horsepower starting capacity
 - c. Fuel consumption at full load
 - d. Engine/alternator cooling air flow (heat rejection)
 - e. Transient response and steady state governing
 - f. Alternator temperature rise
 - g. Single step load pickup
 - h. Harmonic analysis indicating THD for voltage and current
 - i. Short circuit test indicating maximum current withstand
 - j. Torsional analysis
 - k. Sound level (dB) at 23 feet from unit.
- B. Factory tests on the engine generator set shall be conducted, certified, documented and submitted to the Engineer for review prior to shipment. The test shall be conducted at rated load and 0.8 power factor in accordance with NFPA Factory Test Reports. Tests shall include the following:
 1. Steady-state voltage and frequency analysis
 2. Transient response
 3. Maximum power output
 4. Fuel consumption
 5. Safety shutdowns
- C. Documentation that certifies the standby generator will meet the current Environmental Protection Agency (EPA) and any other state or local emission standards for stationary compression ignition internal combustion engines.

1.04 OPERATING AND MAINTENANCE MANUALS

- A. Identify the size, model and features for each item.
- B. Furnish operating instruction manuals outlining step-by-step procedure required for system startup and operation, including manufacturer's name, model number, service manual parts list and brief description of all equipment and basic operating features. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
- C. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or

components not related to equipment furnished must be removed or crossed out. *O&M manuals must be individually tailored to the project and equipment as furnished.*

- D. Furnish maintenance instruction manuals outlining maintenance procedures, including a troubleshooting guide listing possible breakdown and repairs, and a simplified connection wiring diagram for the system.
- E. Copy of warranties issued on the installation, showing dates of expiration.
- F. Refer to Specification Section 16010 for additional requirements.

1.05 QUALITY ASSURANCE

- A. Contractor to ensure that concrete pad, conduit, conductors and branch circuit device ratings are suitable for the equipment supplied. Contractor shall coordinate with the generator set manufacturer for proper conduit stub up locations prior to installation.
- B. Contractor shall review the installation of the generator and all related equipment as indicated on the Drawings with the generator manufacturer's representative prior to submittal or shop drawing preparation. Any concerns with the installation as designed shall be brought to the attention of the Engineer immediately. Failure of the generator to operate properly due to confinements of the installation, whether by design or not, will be corrected by the Contractor at no cost to the Owner.
- C. The generator set manufacturer shall be responsible for and guarantee that the standby generator will operate at full load for 16 hours continuous at the location indicated on the Drawings. Any upgrading of components or modifications to the generator set required for proper operation (larger radiator, remote mounted radiator, fuel cooler, air intakes/ventilation, louvers, etc) shall be done at no cost to the Owner.
- D. The standby generator shall meet the latest Environmental Protection Agency (EPA) emission standards adopted by the authority having jurisdiction in the location where this generator will be installed.
- E. Where required by the EPA, State or other authority having jurisdiction, the Contractor shall be responsible for obtaining an Air Quality Permit for the Owner to operate the standby generator. The permit shall be obtained from the Arizona Department of Environmental Quality and/or any other authority having jurisdiction. The permit shall be filled out in the Owners name. Permit cost will be reimbursed by the Owner.

1.06 WARRANTY AND SERVICE

- A. A manufacturer's warranty shall be furnished on all components, parts, assemblies and performance of the generator against defects in materials and workmanship for a period of 2-years from the date of shipment. Warranty shall include parts, labor and travel expenses.

- B. The equipment manufacturer must have a local service center within a 400-mile radius of the project site with stocked spare parts and staffed with trained, full-time employees who are capable of performing testing, inspecting, repair, and maintenance services.

1.07 MANUFACTURERS

- A. Caterpillar Tractor Co., Peoria, IL
- B. Cummins Power Systems, Minneapolis, MN
- C. Generac Power Systems, Waukesha, WI

PART 2 -- PRODUCTS

2.01 GENERAL

- A. The engine, generator and all associated equipment as specified herein shall provide standby power during periods of normal power failure from utility.
- B. The engine-generator set shall consist of one engine and one generator.
- C. The engine-generator set shall be mounted on a structural steel frame or skid. Vibration isolators suitable to prevent transmission of vibration to the concrete pad shall be provided between the set and the frame.
- D. The engine-generator set shall have a minimum standby power KW rating as indicated on the Drawings at 0.80 power factor. Apply all temperature and elevation derates as necessary to verify that the minimum generator KW ratings indicated are correct.
- E. The generator shall operate at a speed not to exceed 1,800 rpm, and have an output voltage and phasing to match that of the *Normal* source.
- F. Instantaneous voltage dip for all possible sequences of load application and motor starting for loads described in conditions of service shall not exceed 30 percent of nominal voltage. Instantaneous voltage dip for step starting the loads as indicated below shall not exceed 30 percent of nominal voltage.
- G. Frequency regulation shall be isochronous from no load to rated load.
- H. Voltage regulation from no load to rated load shall have cyclic variations in RMS voltage not to exceed +/- 1.0 percent and a speed variation not to exceed +/- 5.0 percent of rated speed.

2.02 GENERATOR:

- A. Generator shall be rated for standby duty; shall be a 4-pole rotating field, engine-driven, direct-connected, synchronous type with amortisseur windings. Generator frame shall be dripproof with all openings guarded. Bearings shall be a single, prefabricated, sealed ball type.
- B. Generator insulation shall be Class H in accordance with NEMA Standard MG1-1.65 and BS2757. 125°C temperature rise at standby power rating.

- C. The AC generator, voltage regulator and exciter shall be designed and manufactured by the generator set manufacturer.
- D. Voltage regulator shall be an automatic, temperature compensated, solid-state type with a manual adjustment range of plus or minus 5 percent of rated voltage. The voltage regulator shall be equipped with 3-phase RMS sensing, overvoltage and overexcitation protection. Overvoltage and overexcitation protection features shall latch requiring the generator to be shutdown for reset.
- E. Exciter shall be brushless with full-wave silicon diodes mounted on the rotating shaft with a surge suppresser connected parallel with the field winding. Exciters utilizing field discharge resistors is not acceptable. Minimum rating of exciter shall be as indicated in NEMA Std. MG-1-22.16.
- F. Fast acting fuses or other protective devices shall be incorporated where failure of regulator or exciter components could result in damage to the generator field or exciter windings.
- G. Voltage regulator and static exciter shall be mounted in generator control panel or elsewhere so as to protect from and isolate from vibration.
- H. Generator and exciter shall conform to all applicable requirements of NEMA Standards, Publication MG1-1987, for Motors and Generators. Generators and exciters shall also conform to ANSI Standards C50.5, Rotating Exciters for Synchronous Machines and C50.12 Salient Pole Synchronous Generators and Condensers, as applicable.
- I. A permanent magnet generator (PMG) shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by nonlinear SCR controlled loads on the generator. The PMG shall sustain main field excitation power for optimum starting and to sustain short circuit current for selective operation and coordination of system overcurrent devices.
- J. Generator lead terminal box shall be of sufficient size to accept and terminate conductors as indicated on the Drawings. Field terminations to the generator leads shall be furnished with the proper terminal lugs suitable for the conductor size(s) as indicated on the Drawings.

2.03 DIESEL ENGINE

- A. Heavy-duty compression-ignition, cold-starting diesel type arranged for direct connection to an alternating current generator. It shall be a current model of a type in regular production by a manufacturer regularly engaged in building this type of diesel engine.
- B. Engine shall have at least a published intermittent brake horsepower rating at specified generator speed required by generator at rated full load output and shall operate without undue heating, vibration, or wear.
- C. Engine shall be four-cycle and may be naturally aspirated, or scavenged.
- D. Engine shall operate on *low sulfur* No. 2 diesel fuel oil.

- E. An electronic governor consisting of a speed sensor, adjustable electronic control and an actuator to provide automatic isochronous generator set frequency control.
- F. Performance, materials, and workmanship shall be in accordance with Diesel Engine Manufacturers Association standard practices.

2.04 FUEL STORAGE SYSTEM

- A. Provide a double-wall fuel tank with spill containment under the structural steel base. As a minimum the tank shall incorporate threaded pipe connections for fuel level gauge, fuel leak detection, low fuel level sensor, fuel suction line, fuel return line, vent, drain and a 1" spare port. Leak detection and a low fuel level sensor shall be pre-wired to the generator control panel with dry contacts for remote monitoring.
- B. Tank shall have capacity to operate generator at full load for 24-hours minimum.
- C. **Tank design shall be such that gauges, control panel and operating mechanisms (circuit breaker handle, emergency stop button, keyed switch, etc) are not located more than 72-inches above the concrete pad.**

2.05 ENGINE FUEL SYSTEM

- A. Diesel fuel system shall consist of an engine-driven, positive displacement fuel supply pump, fuel filters, and a secondary contained fuel piping system.
- B. Fuel filters shall be replaceable without breaking any fuel line connection or disturbing fuel pumps or any other part of engine. Oil filters shall be conveniently located ahead of injection or circulating pump so that fuel is thoroughly filtered before it reaches injectors. Screens or filters requiring cleaning or replacement shall not be used in injection or circulating pump, or in injection valve assemblies.
- C. Water separators shall be furnished to separate the water from the diesel fuel. A probe to detect water in the diesel fuel shall be provided to activate the Generator Failure/Malfunction alarm when the presence of water is detected in the fuel.

2.06 ENGINE COOLING SYSTEM

- A. The generator set shall be supplied with a closed-loop, skid-mounted radiator with a belt-driven fan and integral jacket water circulating pump.
- B. Provide radiator of sufficient capacity to operate the engine generator set at full load in 100°F ambient temperature at site elevation for 16 consecutive hours.
- C. Provide water jacket heater(s) to provide positive water circulation, thermostatically controlled to operate between 100 and 120°F. Voltage shall be 120V for 2kW and below or 240V, 1Ø for heaters over 2kW. Heater shall be equipped with a power cut-off relay and shutoff valves at both inlet and outlet sides.

2.07 ENGINE LUBRICATION

- A. Provide full pressure system, supplying oil to all surfaces requiring lubrication. Circulation shall be by positive displacement pump. Full flow-type filters or filters with bypass feature shall be included. Filter elements shall be replaceable without disconnecting oil piping. Provide an oil cooler, if recommended by engine manufacturer, to properly lubricate engine at full rated generator load.

2.08 ENGINE APPURTENANCES

- A. Furnish engine with following appurtenances:
 - 1. Combustion air cleaner of oil bath type or dry replaceable filter type. A tube shall connect crankcase breather with air cleaner to prevent accumulation of objectionable smoke and fumes.
 - 2. Exhaust silencers for residential silencing complete with drains and flexible stainless-steel connection. Design and provide exhaust piping system, including seismic analysis, vibrations isolators, expansion joints.
 - 3. Exhaust piping shall be steel with flexible connections. The exhaust piping shall include a condensation trap(s) with drain valve(s) to prevent water from entering the engine. An exhaust rain cap and all necessary fittings shall be provided on the stack outlet.
- B. The generator set shall be supplied with a molded case, thermal magnetic type main circuit breaker, mounted and wired. Voltage and amperage shall be as indicated on the Drawings. Amperage Interrupting Capacity (AIC) shall match or exceed maximum RMS symmetrical short circuit current available from the generator during a bolted phase-to-ground fault.

2.09 ENGINE ELECTRICAL SYSTEM:

- A. Electrical system shall include batteries, electric starter, voltage and current-regulated charging generator or alternator, and a separate battery charger. Both a manual starting switch and fully automatic starting from a remote pilot device shall be furnished.
- B. Batteries and starter shall be of suitable capacity to start engine through three starting cycles of 10 seconds each. If the generator has not started after three starting cycles, it shall be shutdown automatically until manually reset.
- C. Battery charger shall be automatic, two rate type providing for equalizing charge and continuous taper charging. Output characteristics shall match requirements of battery furnished. Provide charger suitable for operation on 120 volt, single-phase, 60-Hertz current to be rated not less than 10-amp direct current. Furnish battery charger with following features:
 - 1. Direct current voltage regulation: plus or minus 2 percent for variations in line voltage of plus or minus 10 %.
 - 2. Direct current voltmeter and direct current ammeter, each with suitable scales.
 - 3. Automatic surge suppresser.

4. Automatic current limiting to prevent overloading due to engine cranking, shorted output or reversed battery connections.
 5. Alternating current line fusing.
 6. Built-in equalize charge timer.
 7. Integral protection to prevent battery discharge through charger on loss of alternating current line voltage.
 8. Set of normally open dry contacts to close on Low Battery Alarm.
- D. Provide battery rack with battery hold-down clamps to accommodate starting batteries within the generator enclosure.

2.10 CONTROL PANELS

- A. The generator set shall be provided with a microprocessor based control system to provide automatic starting, monitoring and control functions for the generator set. The control panel shall be UL 508A labeled and manufactured by the generator manufacturer specifically for the generator set supplied.
- B. The control panel shall be mounted on the generator with vibration isolators. The maximum height above grade or viewing platform to the center of the highest digital display or meter shall not exceed 66". Where the control panel digital display mounting height exceeds this, it shall be reinstalled by the generator manufacturer or the Contractor shall fabricate a steel framed 36" x 36" viewing platform with aluminum grating and stairs at no cost to the Owner.
- C. Control panel doors and all door-mounted devices shall be gasketed and dust-tight. All remote control and monitoring signals shall be terminated on terminal blocks.
- D. The control panel shall be provided with the following controls/meters:
1. RUN/OFF/AUTO selector switch (3-position switch or keypad)
 2. Mushroom head, maintained EMERGENCY STOP pushbutton
 3. ALARM RESET pushbutton
 4. PANEL LAMP pushbutton to illuminate controls and meters
 5. Voltmeter
 6. Ammeter
 7. Frequency meter
 8. Kilowatts (kW)
- E. The following status and alarms shall be displayed on the digital display panel:
1. Engine Oil Pressure (psi)
 2. Low Oil Pressure Alarm
 3. Engine Coolant Temperature (°F)
 4. High & Low Coolant Temperature Alarms
 5. Overcrank Alarm

6. Overspeed Alarm
 7. High & Low DC Voltage Alarms
 8. Low Fuel Alarm
 9. High & Low Output Voltage Alarms
 10. Under frequency Alarm
 11. Overload/Overcurrent Alarm
 12. Ground Fault Alarm
 13. Engine Speed (RPM)
 14. Running Time (hours)
 15. Battery Voltage (DC Volts)
- F. The control system shall include a ground fault monitoring relay with an adjustable time delay for alarm. The ground fault relay shall be used for alarm monitoring only, not to trip the main circuit breaker, unless otherwise indicated.
- G. Form "C" dry contacts shall be provided for remote monitoring of alarms as indicated on the Drawings. The contacts shall be rated 2A at 30 VDC, minimum.

2.11 OUTDOOR WEATHERPROOF ENCLOSURE

- A. Provide a weatherproof enclosure for the engine, and associated components.
1. Enclosure shall include an updraft duct with bird screen on the radiator end to direct the generator's discharge air upward.
 2. Enclosure to have fully gasketed doors for access to all portions of the generator that requires any maintenance. All doors to have rain molding above door opening, stainless steel hinges and a two point latch to allow the doors to be completely removed. Handles to be the key locking type.
 3. As a minimum, the enclosure roof, walls and doors shall contain 1/2" deep support ribs with 16 gauge minimum exterior steel with interior sound attenuation insulation. Insulation shall consist of minimum #6 density wool held in place with a perforated liner.
 4. All seams shall be caulked with a sealer prior to painting. Paint exterior surfaces of equipment with two coats of acceptable oil and heat-resistant paint, applied after surfaces have been thoroughly cleaned and prepared with suitable priming coat. **Exterior color shall be desert tan unless otherwise directed by the Owner.**
 5. Provide fixed louvers with a screened cover over air openings sized as required for proper airflow.
 6. The enclosure shall have a steel base channel constructed to drop *over* the generator set with anchor boltholes for fastening to the generator frame or concrete slab.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Install unit complete and make operational.
- B. Install muffler(s) horizontally above the unit.
- C. Provide ½-inch (12mm) copper drain with draincock on bottom of muffler to nearest drain for periodic draining of muffler.
- D. Provide vibration isolation of exhaust equipment to prevent transfer of vibration into building components.
- E. Provide vibration isolators suitable to prevent transmission of vibration from the generator frame to the concrete pad or building floor. Securely anchor the generator frame to the concrete pad/floor with galvanized anchor bolts shall be furnished by engine-generator set manufacturer. Obtain from supplier of engine-generator set a drawing giving location and size of foundation bolts for unit proposed, in sufficient time to be available when needed to place foundation.
- F. Electrical equipment and materials shall be listed by UL wherever standards have been established by that agency.

3.02 WIRING AND CONNECTIONS

- A. Provide conduit, wiring, and connections required and recommended by generator supplier. All conduit and fuel line stub-ups shall be contained within the generator set frame.
- B. Connect generator frame to the electrical service grounding system as indicated on the Drawings. The generator neutral conductor shall be run to the service entrance equipment isolated from ground via the automatic transfer switch and bonded to the service equipment neutral bus.
- C. For 3Ø, 3W standby power supply: Install a main bonding jumper (MBJ) between the generator neutral and the generator ground bus/frame. Size as indicated on the Drawings for the service entrance section.
- D. For 1Ø, 3W standby power supply: Do not install a main bonding jumper (MBJ) between the generator neutral and ground bus/frame. If the generator is furnished with a MBJ, the Contractor shall remove it before conducting any standby power system testing. The neutral conductor shall be run to the service entrance equipment isolated from ground via separate terminals in the automatic transfer switch and bonded to the service equipment neutral bus.

3.03 TESTING

- A. On-site Tests:
 1. Unless certified in the factory test report, the generator manufacturer must pressure test the fuel line and the secondary containment piping in accordance with the Uniform Fire Code and any applicable Local, State, or Federal requirements.
 2. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown and return to normal. Record the

time to achieve standby power after loss of the *Normal* power source. Record the time to retransfer back to the *Normal* power source.

3. Verify fuel tank is full, then provide a full load test for the aeration system standby generator utilizing a portable resistive load bank, for eight (8) hours. Full load shall be the kVA as indicated on the generator set nameplate. Supply all fuel and portable test bank required for testing.
 - a. Record in 20 minute intervals during the on-site test:
 - 1) Time of Day
 - 2) Kilowatts
 - 3) Amps
 - 4) Voltage
 - 5) Coolant temperature
 - 6) Air temperature
 - 7) Frequency
 - 8) Oil pressure
 - 9) Battery charging rate
 - b. Test all alarm and shutdown circuits by simulating fault or failure conditions.
 - c. Refill fuel tank after full load test is complete and record the volume of fuel required to refill the tank.

3.04 TRAINING

- A. Operator training shall be provided by the generator manufacturer's factory-trained representative.
- B. The training shall be conducted at the project site.
- C. The training session shall include up to four Owner's representatives.
- D. The training session shall be a minimum of four (4) hours, conducted on a normal workday as decided upon by the Owner.
- E. The training session shall include the proper maintenance and operation of the standby generator and automatic transfer switch.

****END OF SECTION****

SECTION 16260

AUTOMATIC TRANSFER SWITCH

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Automatic transfer switches, 600V and below with accessories as indicated herein.

1.02 REFERENCE:

- A. STANDARDS:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. ICS, General Standards for Industrial Control and Systems.
 - 2. Institute of Electrical & Electronic Engineers (IEEE).
 - 3. Underwriters Laboratory (UL) 1008
 - 4. National Fire Protection Association (NFPA):
 - a. NFPA-110, Standard for Emergency and Standby Power Systems.

1.03 SUBMITTALS:

- A. Submit the following:
 - 1. Product Data: Provide catalog data on all components in accordance with this specification.
 - 2. Drawings: Interconnection wiring diagrams for the generator control systems indicating control connections between the generator and automatic transfer switch. Power and control wiring conduit entrance locations.

1.04 OPERATING AND MAINTENANCE MANUALS

- A. Identify the size, model and features for each item.
- B. Furnish operating instruction manuals outlining step-by-step procedure required for system startup and operation, including manufacturer's name, model number, service manual parts list and brief description of all equipment and basic operating features. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
- C. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or components not related to equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
- D. Furnish maintenance instruction manuals outlining maintenance procedures, including a troubleshooting guide listing possible breakdown and repairs, and a simplified connection wiring diagram for the system.

- E. Copy of warranties issued on the installation, showing dates of expiration. Warranty period shall begin at date of substantial completion.
- F. Refer to Specification Section 16010 for additional requirements.

1.05 QUALITY ASSURANCE

- A. Contractor to ensure that conduit size and wire quantity, size, and type are suitable for the equipment supplied.
- B. Comply with the following Codes and Standards:
 - 1. UL listing and labeling for materials.
 - 2. UL 1008
 - 3. NFPA-70.

1.06 WARRANTY AND SERVICE

- A. A manufacturer's warranty shall be furnished on all components, parts, assemblies and performance of the transfer switch for a period of 2-years from the date of substantial completion. Warranty shall include parts, labor and travel expenses.
- B. The equipment manufacturer must have a local service center within a 400-mile radius of the project site with stocked spare parts and staffed with trained, full-time employees who are capable of performing testing, inspecting, repair, and maintenance services.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. ASCO
- B. Russelectric
- C. Zenith
- D. Or equal

2.02 MATERIALS

- A. The transfer switch shall be provided with ratings, number of poles/wires and installed as indicated on the Drawings. The short circuit withstand ampacity shall meet or exceed the indicated AIC rating of the electrical equipment immediately connected to the load side of the transfer switch. The transfer switch shall be capable of switching all classes of loads while under full load.
- B. The transfer switch shall be provided with a NEMA rated enclosure as indicated on the Drawings.
- C. Load transfer shall be delayed transition, three position (center off) electrically and mechanically interlocked contactors. Interlocked circuit breakers are not acceptable.

- D. Main switch contacts shall be silver or have silver alloy surfaces, arcing tips and arc extinguishing devices. Transfer switch shall be capable of closing on an inrush current 20 times its full load rating without contact damage and capable of withstanding a system short circuit fault until the overcurrent device trips. Total transfer time in either direction shall not exceed one-half second. Interlock *Normal* and *Emergency* contactors both mechanically and electrically so that both cannot be closed at any one time.
- E. Switching contactors and cable connections shall have a transparent protective cover to protect operating personnel from accidental contact and allow visual determination of the transfer switch position.
- F. The transfer switch shall be provided with a door mounted, 3-position selector switch or keypad with password for TEST, NORMAL and RETRANSFER manual transfer control which will activate the transfer switch with the same contact-to-contact speed as automatic operation.
- G. There shall be a separate adjustable time delay (0-2 min.) for transferring power from the *Normal* to *Emergency* and retransferring back.
- H. As a minimum, the transfer switch shall be provided with the following:
1. Open transition type controls necessary for a delay in transfer.
 2. Temperature compensated, solid-state voltage sensors shall simultaneously monitor all phases of both normal and standby power sources. Transfer from *Normal* to *Emergency* source shall occur when the *Normal* source voltage and frequency drops below an adjustable 85-95 percent nominal for a period of time as set by the time delay to transfer (0-2 minutes). Retransfer back to *Normal* shall occur when the *Normal* source has been restored to nominal an adjustable 85-95 percent for a period of time as set by the time delay to retransfer (0-30 minutes).
 3. An adjustable time delay (0-5 seconds) with a suitable contact for starting an engine generator upon loss of *Normal* power.
 4. Transfer of power to the standby source shall occur within 10 seconds of loss of *Normal* power.
 5. 250V, 10A, Form "C" auxiliary and control contacts as follows:
 - a. Two contacts that are closed when the transfer switch is in the *Normal* position.
 - b. Two contacts that are closed when the transfer switch is in the *Emergency* position.
 6. After retransfer of power from a standby generator source, the generator shall remain running for an adjustable time period as set by a timing relay (0-10 minutes).
 7. Separate pilot lights to indicate the presence of each source and transfer switch position.

8. Separate status indicators to indicate the presence of each power source, signal to start engine generator, transfer/retransfer timing, transfer/retransfer complete and stop generator timing.
9. Full rated lugs for *Normal*, *Emergency* and *Load* conductors as indicated on the Drawings.
10. Terminal blocks for all control and monitoring field-wiring connections as indicated on the Drawings and as specified herein.
11. A 7-day, 24-hour adjustable exerciser clock or, if indicated on the Drawings, a remote start/stop input shall be capable of exercising the generator set under *No Load* condition.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Install where indicated on plans. Mount unit such that it is level and plumb.
- B. Prior to installation, coordinate with other trades to verify conduits have adequate space to leave and enter the switch enclosure and for required code clearance. A minimum working clearance as defined by the NEC 110-26 shall be provided.
- C. Install in accordance with NFPA 70 and all applicable local codes and regulations.

3.02 TESTING

- A. Factory Tests:
 1. Provide factory production tests in accordance with NEMA standards and NFPA standard 110. Check and set all instruments and safety devices.
- B. On-site Tests:
 1. Simulate utility power failure to verify proper operation of the automatic transfer switch, automatic starting and stopping of the standby generator and retransfer back to utility when utility power is resumed. Record the time to achieve standby power after loss of the *Normal* power source. Record the time to retransfer back to the *Normal* power source.
 2. Verify all status and alarm signals being monitored remotely.
 3. Coordinate with the Owner for programming the exerciser clock settings.

3.03 TRAINING

- A. The Contractor shall provide training by a manufacturer's factory-trained representative.
- B. The training shall be conducted at the project site.
- C. The training session shall include up to four Owner's representatives.
- D. The training session shall be a minimum of two (2) hours, conducted on a normal workday as decided upon by the Owner.

- E. The training session shall include the proper maintenance and operation of the automatic transfer switch.

****END OF SECTION****

SECTION 16401

SERVICE ENTRANCE SECTION

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Furnish and install electrical service entrance section consisting of utility metering and service disconnect.

1.02 SUBMITTALS

- A. Product Data: Submit catalog cuts and manufacturer's descriptive literature for approval for:
 - 1. Service Entrance Section
- B. Shop Drawings:
 - 1. Submit drawings showing dimensions and dimensional clearances within the structure.
 - 2. Include metering per serving utility requirements and main circuit breaker.
 - 3. All electrical characteristics (voltage, phasing, amperage, bracing, interrupting capacity).
- C. Serving electric utility company coordination:
 - 1. The Contractor shall submit the above listed information to the local serving utility for approval of proposed service entrance equipment. The Contractor shall submit written approval from the local utility to the Engineer.

1.03 QUALITY ASSURANCE

- A. Meet requirements of NEC (NFPA 70)
- B. Codes and Standards:
 - 1. NFPA 70-NEC
 - 2. NEMA
 - 3. U.L. listed
 - 4. ICEA
 - 5. IEEE
 - 6. ANSI
 - 7. Local Utility Company
- C. Service equipment shall bear markings "Suitable for Use as Service Equipment" or be UL listed as "Service Equipment."
- D. The manufacturer of the service entrance equipment shall be the manufacturer of the circuit protective device, and other accessories within.
- E. The manufacturer of the service entrance equipment shall be ISO 9000, 9001 or 9002 certified.

- F. The manufacturer of the service entrance equipment shall have produced similar electrical equipment for a minimum period of five (5) years. If requested by the Engineer, a list of installations with successful operation of similar equipment shall be provided demonstrating compliance with this requirement.

1.04 RELATED WORK

- A. Division 16, Electrical

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Sun Valley Electric
- B. Milbank
- C. Eaton
- D. Square D Company
- E. Or equal

2.02 GENERAL CONSTRUCTION

- A. The equipment specified herein shall have the following ratings:
 - 1. Voltage: As indicated on the Drawings
 - 2. Phasing: As indicated on the Drawings
 - 3. Alternating Current Frequency: 60 Hz
 - 4. Bus Bracing: As indicated on the Drawings
 - 5. Bus Amperage: As indicated on the Drawings
 - 6. Protective Device Mounting: Fixed
 - 7. Enclosure: NEMA 3R, surface mounted as indicated on the Drawings.
- B. The service equipment shall consist of an assembly furnished with an incoming line section (overhead or underground as indicated on the Drawings) and a separate barriered-off utility metering compartment complete with hinged sealable door(s). Bus work shall include provisions for mounting utility company current transformers and potential taps or transformers as required by utility. Lugs shall be provided in the incoming line section for connection of the feeder conductors.
- C. The internal components and bussing shall be completely enclosed (metal clad) with dead front construction. All edges of front covers or hinged front panels shall be formed.
- D. All bus bars shall be silver or tin plated copper.
- E. Provide a full capacity neutral landing lug or bus if a three phase, four wire or single phase, three wire system is indicated on the Drawings.
- F. Mechanical type terminals shall be provided for all line and load terminations suitable for copper cable rated for 75°C.

- G. All exterior and interior steel surfaces of the assembly shall be properly cleaned and provided with a rust-inhibiting phosphatizing coating. Color and finish shall be ANSI 61, unless noted otherwise.

2.03 CIRCUIT BREAKER TYPE PROTECTIVE DEVICES

- A. Circuit breakers shall be of the molded case type and shall provide overcurrent protection with inverse time and instantaneous tripping characteristics.
- B. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy, and arc extinction shall be accomplished by means of arc chutes.
- C. Circuit breakers shall have a minimum symmetrical interruption capacity as indicated on the Drawings
- D. Circuit breakers shall have thermal magnetic trip units and inverse time-current characteristics.
- E. The Contractor shall be responsible for the setting of the adjustable protective parameters of the circuit breakers to ensure proper system protection and coordination.

2.04 ARC FLASH WARNING LABEL

- A. Furnish each service entrance section with an Arc Flash Warning label to read:

“WARNING
Arc Flash and Shock Hazard
Appropriate (PPE) Required”

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Furnish and install service entrance equipment as indicated on the Drawings, in accordance with the serving utility’s requirements, in accordance with the NEC and all applicable local codes and regulations.
- B. Install main bonding jumper and provide grounding of service entrance equipment per the NEC, serving utility and applicable local code requirements.

END OF SECTION

SECTION 16450

GROUNDING

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Grounding and bonding of electrical equipment, raceways and specialized systems, including testing.

1.02 SUBMITTALS

- A. Manufacturer's data for the following:
 1. Connection methods
 2. Ground rods
 3. Ground rod wells

1.03 SYSTEM DESCRIPTION

- A. Ground electrical equipment, conduits, supports, cabinets, and switchgear in accordance with NFPA 70 (NEC) and as shown on the Drawings, the intent being a system ground and an equipment ground.

1.04 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (refer to Section 16010):
 1. IEEE 81-1962--IEEE Recommended Guide for Measuring Ground Resistance and Potential Gradients in the Earth.
 2. NFPA 70 (NEC)
 3. NEMA
 4. UL listing
 5. MIL Handbook 419

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Ground Rods:
 1. Anderson Electric Corp.
 2. Copperweld Corp.
 3. Harger

2.02 MATERIALS

- A. Ground rods shall be copperclad rods $\frac{3}{4}$ -inch in diameter and 10-feet long unless indicated otherwise on the Drawings.
- B. Ground rod wells shall be $8\frac{1}{2}$ -inch diameter constructed of reinforced concrete with a reinforced concrete removable cover stamped "GROUND" as manufactured by Christy or equal.

- C. Connectors, mechanical lugs or wire terminals shall be used only to bond ground wires, junction and panel boxes.
- D. Grounding conductors shall be stranded copper, size as indicated on the Drawings or as required by the NEC. Grounding conductors shall be bare or contain green insulation.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Where mechanical lugs are not welded or fastened with a threaded bolt, surfaces shall be thoroughly cleaned and paint scraped to bare metal before connections are made to insure good metal-to-metal contact.
- B. An equipment grounding conductor must be installed in each conduit with power conductors or, in the case of multi-conductor cable, run inside the cable sheath.
- C. The Contractor shall bond the electrical equipment pad rebar to the service grounding electrode system.
- D. A main system ground, bare copper conductors, size as indicated, shall be run in PVC conduit from the service entrance section to the grounding electrode system as indicated on the Drawings.
- E. Connections to ground rods shall be exothermically welded. Ground rod connections shall be done in a ground rod well for inspection purposes. Ground rod connections may also be done with Burndy "HYTAP" type connectors.
- F. All enclosure doors with 120V mounted devices shall be bonded to the enclosure ground bus.

****END OF SECTION****

SECTION 16470
PANELBOARDS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Lighting and power distribution panelboards as indicated on the Drawings and as specified herein.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data demonstrating compliance with this specification and the Drawings. Information shall include but not be limited to:
 - 1. A panel schedule indicating branch circuit number, size and type of individual circuit breakers, interrupting capacity of the device and number of poles.
 - 2. Short circuit current bracing of the panel.
 - 3. Bus material and mounting type.
 - 4. Demonstrate means of identification of each circuit and of each panel by mark corresponding to the Drawings. Explain any deviations.
 - 5. Clearly indicate all dimensions and that it has been verified that the equipment will fit into place.
 - 6. Indicate ground bus kits.
 - 7. Integral surge protective device (SPD) documentation, where applicable.
- B. Test Data: Submit test reports on integrated panel.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (refer to Section 16010):
 - 1. NEMA
 - 2. UL listing
 - 3. NFPA 70 (NEC)
 - 4. W-P-115a Power Distribution, current edition

1.04 RELATED WORK

- A. Section 16010 – Basic Electrical Requirements
- B. Section 16195 – Electrical Identification
- C. Section 16450 - Grounding
- D. Section 16475 – Overcurrent Protective Devices

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Square D Company

- B. Eaton
- C. General Electric Co.

2.02 MATERIALS

- A. Panelboards shall have the following minimum requirements:
 - 1. UL listed with copper bus bars of 98 percent conductivity and minimum cross sectional area based on UL 67 for heat rise. Bus size and ratings shall be in accordance with UL 67. Minimum bus voltage, amperage and short circuit withstand rating shall be as indicated on the Drawings or as required per NEC.
 - 2. Copper bars shall be provided for terminating equipment grounding conductors and neutral conductors, where applicable.
 - 3. Terminals shall be UL rated for use with copper or aluminum conductors.
 - 4. Panelboards shall include a main circuit breaker or solderless main lugs as indicated on the Drawings. Lugs for main lug only panelboards shall be sized to accommodate the incoming power supply conductors.
 - 5. Fully rated feed-thru lugs shall be provided where indicated.
 - 6. Branch breakers shall be the bolt-on type, unless otherwise indicated.
 - 7. A framed directory pocket shall be provided on the inside door with 1/16-inch thick glass or plastic cover and typed written directory card.
 - 8. A manufacturer's stamped steel nameplate shall be riveted to the exterior indicating voltage, amperage, phases and short circuit bracing.
 - 9. Where indicated, circuit breakers shall have a fixed handle padlock attachment capable of locking the circuit breaker in the off position.
 - 10. Enclosures shall be constructed of galvanized steel with a baked-on polyester power coated ANSI-61 light gray finish. Panelboard doors shall consist of a bolt-on steel cover with an integral hinged door for circuit breaker access (door-in-door). Unless otherwise indicated on the Drawings, NEMA ratings shall be as follows:
 - a. Indoor flush mounted: NEMA 1
 - b. Indoor surface mounted: NEMA 12
 - c. Outdoor: NEMA 3R, gasketed with tamperproof screws
 - 11. Three phase panelboards shall have a minimum of 5-inch wide top and bottom gutters and 6-inch side gutters. Power distribution panelboards may be larger to accommodate larger branch breakers or subfeed breakers.

2.03 SURGE PROTECTION DEVICE (SPD)

- A. Where indicated, panelboards shall be furnished with an integral Type 2 SPD specifically designed for installation in the panelboard. The unit shall have the following features and functions:
 - 1. ANSI/UL 1449 Third Edition.
 - 2. UL 1283 listed for high frequency noise.

3. UL 845 listed for motor control centers.
4. All modes of protection: L-N, L-G, L-L, N-G
5. The minimum Surge Current Capacity per phase shall be as indicated on the Drawings.
6. The maximum UL 1449-Third Edition VPR for the protection of each mode shall not exceed the following:

<u>Mode</u>	<u>277/480</u>	<u>120/240V</u>
Line-Neutral	<u>1200 VAC</u>	<u>700 VAC</u>
Line-Ground	<u>1200 VAC</u>	<u>1000 VAC</u>
Neutral-Gnd	<u>1200 VAC</u>	<u>700 VAC</u>
Line-Line	<u>2000 VAC</u>	<u>1200 VAC</u>
7. Status pilot lights to indicate unit is powered and operating properly. Separate pilot light(s) shall indicate unit or individual phase protection module failure.
8. Form C alarm contacts for remote monitoring unit failure.
9. Minimum 5 year warranty.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Prior to installing panelboards, verify conduits have adequate space to enter the panelboard and to provide the required code clearance. A minimum working clearance as defined by the NEC 110-26 shall be provided. Whether the panelboard is installed indoors or outdoors, the working space as defined in Table 110-26(a) of the NEC shall apply.
- B. Panelboards shall be installed such that the highest circuit breaker handle is not more than 6'-7" above finished floor.
- C. Provide a means of keeping unauthorized hands out of live panels during construction when panelboard fronts have not been installed.
- D. Complete the panelboard schedule by accurately typing in a brief load description for the appropriate circuit number. Place a copy of the panelboard schedule in the pocket of the panelboard door.
- E. Each branch circuit conductor shall be clearly identified by color as to the phase connection. Wiring in panels shall be neat with rounded corners and tied in bundles with approved ties. See Section 16120.
- F. Where a common neutral is run for more than one branch circuit, the phase conductors shall be connected to separate, consecutive phases in order that the neutral will carry only the unbalanced current in each phase. Neutral conductors shall be same size as phase conductors unless specifically noted otherwise.
- G. Surface Mounted Panelboards:

1. Shall be installed plumb and level, and in accordance with manufacturer's directions.
 2. Surface mounted panelboards shall be securely bolted to the walls.
- H. Panelboards Mounted in distribution switchboards:
1. Panelboards in distribution switchboards shall be installed by the switchboard manufacturer.

3.02 BALANCING

- A. Panelboard circuiting shall be as indicated on the Drawings whenever possible. Additional loads shall be placed to balance loads between phases as much as possible.

****END OF SECTION****

SECTION 16475

OVERCURRENT PROTECTIVE DEVICES

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Overcurrent Protective Devices such as fuses and circuit breakers.

1.02 SUBMITTALS

- A. Fuses: Submit catalog cuts which indicate the fuse symbol and ampere rating for each disconnect or device.
1. Submit manufacturer's data showing fuse name, symbol, voltage rating, UL class, interrupting capacity or I-squared time (I^2t) characteristics and accessories.
 2. Fuse trip curves.
- B. Breakers: Submit catalog cuts that indicate type of breaker, size, trip, characteristics, interrupting capacity, and the specified features.

1.03 OPERATING AND MAINTENANCE MANUALS

1. Identify the size, model and features for each item.
2. Complete instructions regarding the operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. *O&M manuals must be individually tailored to the project and equipment as furnished.*
3. Refer to Specification Section 16010 for additional requirements.

1.04 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (see Section 16010):
1. NFPA 70 (NEC)
 2. UL listing
 3. ANSI
 4. NEMA

1.05 RELATED WORK

- A. Division 16, Electrical

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Fuses:
1. Bussmann Mfg. Div.
 2. Gould-Shawmut
 3. Little-Fuse

- B. Circuit Breakers:
 - 1. Schneider
 - 2. Eaton
 - 3. General Electric Co.

2.02 MATERIALS

- A. Fuses:
 - 1. Fuses up to 600 volts shall meet the following:
 - a. Be of the same manufacturer.
 - b. Shall NOT be shipped in fused switches.
 - c. Shall be stored in a safe, moisture free area until needed.
 - d. All dual element fuses shall have separate overload and short circuit elements. The overload element shall include a spring-assisted thermal unit. The thermal unit shall open on a temperature rise above 280 degrees Fahrenheit. Time delay for the overload element shall be at least 10 seconds at 500 percent of rated amperes.
 - e. When indicated on the Drawings or required by the local authority or serving utility, fuses shall be silver-sand UL Class R or Class L current-limiting fuses (low-peak dual element).
 - f. Motor branch circuit fuses rated 1/10 to 600 amperes shall be sized one ampere rating above the selected heater element. Fuse ampere rating shall not exceed 175 percent of motor FLA. Abnormal motor conditions requiring increased ampere ratings shall be referred to the Engineer. Fuses shall be UL Class R current-limiting dual element with time delay.
- B. Circuit Breakers:
 - 1. Low voltage breakers up to 600 volts shall meet the following:
 - a. Be quick-make, quick-break type.
 - b. Have toggle mechanism insuring full contact pressure until time of opening whether manually or automatically operated.
 - c. Thermal magnetic type to have inverse time tripping characteristics with fixed thermal trip action to hold on harmless momentary overload.
 - d. Adjustable trip setting shall be provided for all service entrance section main circuit breakers.
 - e. A short circuit condition shall cause the magnetic trip element to instantly trip without damage or injury.
 - f. Have non-welding, non-corroding contacts.
 - g. Be full-size with mechanism enclosed in molded bake-lite case, sealed to prevent tampering or unauthorized changes in calibration.

- h. Be UL listed and recognized.
- i. Meet NEMA standards.
- j. Be bolt-on type unless otherwise specified.
- k. Have contacts that operate in a multiple plate arc-quenching chamber vented to load side of breaker - UL listed.
- l. Be rated for AIC compatible with ratings of the panel or switchboard bus they are to be used in as indicated on the Drawings. Unless otherwise indicated, series rated devices are not acceptable. All overcurrent devices shall be fully rated.
- m. Be calibrated for operation in a minimum ambient temperature of 50 degree C.
- n. All multi-pole breakers shall have common trip.
- o. For multi-pole breakers shall require the same space as the equivalent number of single pole breakers. Wafer style breakers are unacceptable.
- p. Have operating handle that visually indicates “on”, “off”, or “tripped”.
- q. Be labeled to indicate circuit number(s) and load served.
- r. Be rated for 100% continuous operation where indicated on the Drawings.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Provide overcurrent protection for all wiring and equipment in accordance with NFPA 70, State or local codes, whichever is prevailing.
- B. Should nameplate data disagree with the size or application of an overcurrent protective device indicated on the Drawings, immediately bring it to the attention of the Engineer for a decision.
- C. Place a label inside each fused switch door. Label shall indicate fuse type, ampere rating and interrupting rating. Manufacturers’ labels are acceptable.
- D. Where blank spaces or spaces designated for future overcurrent devices are indicated on the Drawings, they shall be complete with bus links.

3.02 SPARE PARTS

- A. Furnish one spare set of three (3) of each size and type of fuse rated at more than 30 amperes, and 10 percent of each size and type of fuse rated 30 amperes or less, but in no case less than one set of three (3).

****END OF SECTION****

SECTION 16480

MINI-POWER CENTERS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Combination transformer/panelboard units commonly referred to by manufacturer trademark as “Mini-Power Center”.

1.02 SUBMITTALS

- A. Product Data: Provide catalog data on all components in accordance with this specification including the combination transformer/panelboard and circuit breakers contained within.
- B. Provide a panel schedule indicating each circuit breaker with load description.
- C. Provide the two-tier series rating of the mini-power center primary circuit breaker with the mini-power center branch circuit overcurrent device where the AIC on the branch circuit overcurrent device has a higher AIC rating than the mini-power center primary circuit breaker.

1.03 OPERATING AND MAINTENANCE MANUALS

- 1. Identify the size, model and features for each item.
- 2. Complete instructions regarding the operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. *O&M manuals must be individually tailored to the project and equipment as furnished.*
- 3. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or components not related to equipment furnished must be removed or crossed out. *O&M manuals must be individually tailored to the project and equipment as furnished.*
- 4. Refer to Specification Section 16010 for additional requirements.

1.04 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards:
 - 1. NEMA (Testing Standards BU 1.3.03 or 1.304)
 - 2. UL listing and labeling for materials.
 - 3. NFPA-70

1.05 RELATED WORK

- A. Specification Section 16195, Identification
- B. Specification Section 16475, Overcurrent Protective Devices

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Schneider
- B. Eaton
- C. General Electric

2.02 MATERIALS

- A. Mini-Power Centers shall have KVA rating as indicated on the Drawings.
- B. Mini-Power Center Units shall include integrally mounted and wired transformer primary and secondary main circuit breakers in accordance with NFPA 70 requirements.
- C. Transformer shall have 480V primary and 120/240V, 1Ø or 120/208V, 3Ø secondary as indicated on the Drawings.
- D. Transformer shall have 2-5 percent primary taps below normal. Transformer to be encapsulated in a sand-epoxy resin to protect against moisture, rust and corrosive environments.
- E. Bussing shall be copper.
- F. Branch circuit breakers shall be bolt-on type and as specified elsewhere in these specifications.
- G. Enclosures shall be cleaned, phosphatized and electrostatically powder coated and shall be UL Listed for outdoor use. A padlockable hinged access door shall be provided which maintains itself in the open position.
- H. Where the AIC rating of the primary circuit breaker is less than the short circuit rating of the electrical switchboard feeding the mini-power primary breaker, a two-tier series rated system must be furnished to provide adequate protection of the mini-power center. The mini-power center must be clearly marked and labeled by the manufacturer that specifically indicates its suitability for use with series rated systems as required by the NEC 110-22 as follows:

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Install where indicated on plans. Mount unit such that it is level and plumb.
- B. Prior to installing mini-power centers, coordinate with other trades to verify conduits have adequate space to leave and enter the tub and for required code clearance. A minimum working clearance as defined by the NEC 110-26 shall be provided.
- C. Securely fasten to wall of building or equipment with stainless steel bolts, nuts and lock-washers.
- D. Insert accurate panel schedule on inside of enclosure door or clearly write load description on mini-power center inner door next to each circuit breaker with a permanent black marker.

- E. Label each circuit conductor with its associated branch circuit number per Specifications Section 16195.
- F. Install nameplate on exterior of Mini-Power Center to indicate panel designation. Fasten nameplate using stainless steel self-tapping screws.
- G. Bond secondary of transformer to the service or grounding electrode system with copper grounding conductor sized as indicated on the Drawings or per NFPA 70.

****END OF SECTION****

SECTION 16500

LIGHTING

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Luminaires and lamps.

1.02 SUBMITTALS

- A. Submit manufacturer's data for the following:
1. Luminaires with designation as indicated on the Drawings.
 2. Lamps (type, color, wattage, etc.).
 3. Light pole with accessories, including foundation details.
- B. Submit manufacturer's data demonstrating compliance with Specifications and the luminaires as indicated on the Drawings.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (see Section 16010):
1. UL listed and labeled.
 2. NEMA
 3. NFPA 70 (NEC)
 4. IES

PART 2 -- PRODUCTS

2.01 MATERIALS

- A. Luminaires shall be:
1. Furnished with proper outlet boxes, hardware, supports, canopy extensions, etc.
 2. Furnished complete with gaskets and UL Listed for wet locations.
 3. Furnished complete with lamps with wattage and voltage as indicated on the Drawings.
 4. Furnished with specified finish and color.
- B. Lamps:
1. LED's and their driver shall be designed for minimum operational life of 50,000 hours in -20°C to 40°C ambient air temperature. The lumen output shall not decrease by more than 20% over the operational life. The driver shall decrease output power when the ambient air temperature is outside the -20°C - 40°C range instead of shutting the LED's off. The driver shall be UL listed and include a quick disconnect plug for maintenance. Kelvin temperature shall be 4000K unless otherwise indicated on the Drawings.
- C. Photocells:

1. Photocells shall operate on 120VAC unless otherwise indicated and housed in a heavy-duty, weatherproof housing.
 2. Normally open contacts shall close when ambient light falls to approximately 3-footcandles and open at approximately 12-footcandles.
- D. Light Poles:
1. Light poles shall be constructed of square aluminum tubing with a flush-mounted GFCI receptacle and light switch as indicated on the Drawings.
 2. Area light pole foundations must be designed for 80 mph wind loading with 100 mph wind gusts.

PART 3 -- EXECUTION

3.01 INTERFERENCES

- A. Contractor shall carefully examine the complete areas as well as each individual room where luminaires are to be installed, for interference with piping and other trades. Where such interferences occur, provide luminaires with proper type suspension to overcome such interferences.

3.02 INSTALLATION

- A. Augured holes with rebar cage installed shall be inspected by the Engineer prior to pouring concrete.
- B. Luminaires shall be installed parallel with walls and ground for a neat appearance. Where luminaires are indicated to be mounted on a perimeter wall, luminaires shall be installed on a flush mounted box at an elevation such that the top of fixture is flush with the top of wall.
- C. Operate luminaires after installation and connection. Check for proper operation. Replace luminaires that have failed or are not functional.

3.03 OPERATION

- A. Wall mounted luminaires shall be controlled by a light switch located on the enclosure wall as indicated on the Drawings.
- B. Pole mounted luminaires shall be controlled by a photocell and light switch located on the pole as indicated on the area light pole detail. The luminaire will operate from dusk-to-dawn using the photocell when the light switch is left in the ON position.

****END OF SECTION****

**KAYENTA WWTP
UPGRADE
ELECTRICAL SPECIFICATIONS
TABLE OF CONTENTS**

16010..... Basic Electrical Requirements

16110..... Raceways

16120..... Wires and Cables (600V or Less)

16130..... Boxes

16140..... Wiring Devices

16195..... Electrical Identification

16250..... Diesel Engine Generators

16260..... Automatic Transfer Switch

16400..... Freestanding Service Entrance Section

16401..... Wall-Mounted Service Entrance Section

16425..... Distribution Switchboards

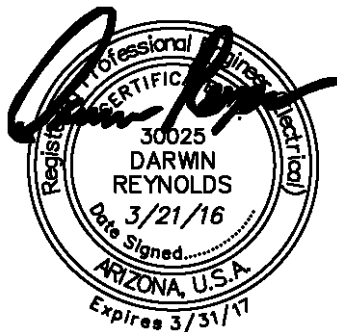
16450..... Grounding

16461..... Transformers (Dry-Type)

16470..... Panelboards

16475..... Overcurrent Protective Devices

16500..... Lighting



SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Electrical general provisions as indicated, specified and required for constructing a complete, ready for use electrical system as described in these Contract Documents.
- B. Labor, materials, apparatus, and appliances essential to the complete functioning of systems described and indicated herein, or which may be reasonably implied as essential, whether mentioned in the Contract Documents or not, shall be furnished and installed by the Contractor. In case of doubt as to the work intended, or in the event of need for explanation thereof, Contractor shall refer to the Engineer for supplemental instructions.
- C. All items not specifically mentioned in these Specifications or noted on the Drawings, or on shop drawings, but which are necessary to make a complete and satisfactory, working electrical/instrumentation installation, shall be deemed to be included herein.
- D. All electrical equipment shall be capable of operating successfully at full-rated load, without failure, at an ambient air temperature of -30°C to 50°C, and specifically rated for an altitude of 5600 feet. Where these criteria cannot be met, ancillary equipment and/or special derating factors as approved by the Engineer shall be utilized.
- E. The Contractor shall perform all necessary saw cutting, core drilling, excavating, removal, shoring, backfilling, etc as required for the proper installation of conduits whether inside or outside of the building(s) and structure(s). The Contractor shall repair and patch where demolition has taken place in a manner to match existing original structure.
- F. Since this facility is in continuous operation, the Contractor shall prepare and submit a flow chart and/or written narrative describing the sequence of construction with duration of anticipated power interruptions.

1.02 SUBMITTALS

- A. Submit documentation for review as described in individual Specification Sections for products requiring submission.
- B. Submit Division 16 in one submittal, or at a maximum, the following may be submitted as separate submittals for this project.
 - 1. Commodities (Sections 16010-16195) and Grounding (Section 16450)
 - 2. Standby Generator (16250)
- C. Documentation must be arranged in numerical sequence corresponding with each Specification Section and article of each Section. Soft copies shall be in “pdf”

format with “character recognition” and shall include the following as a minimum:

1. A cover sheet to identify the Contractor’s name, name of the project, date and description, i.e. “Division 16 – Commodities”.
 2. An index corresponding to each specification section with all addendum updates included. Each paragraph or bulleted item shall be check marked to signify compliance with each item and the information is included in the submittal package. If full compliance is not met for any reason, the non-compliance item shall be underlined and reference to a detailed written explanation of the deviation or non-compliance shall be provided in the margin to the right of the specification paragraph or bulleted item for consideration.
 3. Bookmarks within each section for each major component within.
 4. Complete manufacturer name and model number of each item. Listing items “as specified” without both make and model or type designation is not acceptable.
 5. Descriptive Data: complete description, information, and performance data covering materials and equipment that are being proposed. Each component shall be clearly identified on each sheet. Refer to individual specification sections for additional submittal requirements.
- D. If hard copies are provided, they shall be bound in 3-ring binders (2” max) and include all information as described above for soft copies. The binders shall include tabs corresponding to a neatly typewritten index. The binder cover and edge shall clearly identify the Contractor’s name, name of the project, date and submittal number.
- E. Important Notice:
1. **After material or equipment has been submitted and approved, no substitutions will be allowed. Any equipment installed that is different than the approved shop drawings and submittals will be removed and replaced at the Contractor’s expense without exception!**
 2. If Contractor's submittal(s) depart from the Contract Documents, the Contractor shall make specific mention thereof in his letter(s) of transmittal, otherwise review of such submittals by the Engineer shall not constitute review of such departure(s).
 3. The Contractor may be charged for costs incurred by the Engineer for third and subsequent submittal reviews. Cost for Engineer’s review time shall be billed at the Engineer’s standard hourly rates.
- F. For control panels, motor starters and other equipment requiring multiple terminations of components and devices, the Contractor shall submit detailed shop drawings consisting of point-to-point wiring diagrams, bill of materials, interior and exterior elevations with dimensions prepared by the equipment manufacturer or a UL 508A recognized system integrator.

1.03 RECORD DRAWINGS AND OPERATION AND MAINTENANCE MANUALS

- A. Record Drawings: On completion of work, Contractor shall furnish a complete set of Record Drawings and Shop Drawings which properly reflect final locations and sizes of conduit, equipment fixtures, controls, etc., as actually installed. Dimensions shall be included on the Contractor's as-built Drawings showing exact location of underground conduits.
- B. Operation and Maintenance (O&M) Manuals: Contractor shall provide O&M manuals for the 480V service entrance section, distribution switchboard, standby generators and automatic transfer switches furnished under this contract. O&M manuals must be submitted and approved before final inspection of the project so that they may be used during startup. Soft copies shall be in "pdf" format with "character recognition" and shall include the following as a minimum:
1. A cover sheet to identify the Contractor's name, name of the project, date and description, i.e. "Electrical Equipment O&M Manual".
 2. Bookmarks within each section for each major component within.
 3. Complete manufacturer name and model number of each item.
 4. Descriptive data, wiring diagrams, dimensional drawings, etc from the approved submittals/shop drawings.
 5. Complete instructions regarding the installation, operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
 6. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or components not related to equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
 7. Copy of warranties issued on the installation, showing dates of expiration.
- C. Hard copies, if provided, shall be bound in 3-ring binders (2" max) and include all information as described above for soft copies. The binders shall include tabs corresponding to a neatly typewritten index. The binder cover and edge shall clearly identify the Contractor's name, name of the project, date and identified as "Electrical Equipment O&M Manual".

1.04 QUALITY ASSURANCE

- A. The Contractor performing the electrical construction and installation shall be a reputable Contractor licensed in the State of Arizona to do electrical **commercial** construction. As a minimum, an "L-11 Commercial" license is required. If any electrical work over 600V is required, the Contractor must also be licensed to work on High Voltage Electrical and Transmission Lines.
- B. The Contractor must be located within a 400-mile radius of the project and have been in that vicinity for a minimum of five (5) years.

- C. The Contractor must have a minimum of five (5) years experience as a Contractor installing electrical systems for other water and wastewater projects of similar type, size and requirements. If requested, the Contractor must submit documentation and list of references of recent projects similar to this one.
- D. All equipment furnished shall be new and of current design. Like equipment shall be of the same manufacturer.
- E. Unless otherwise indicated, all equipment and components shall be rated for use in the environment installed. Outdoor equipment shall be weatherproof or rated for outdoor use.

1.05 SPACE REQUIREMENTS

- A. Space Requirements: In the preparation of Drawings, a reasonable effort has been made to include equipment manufacturer's recommendations. Since space requirements and equipment arrangement vary according to manufacturer, the responsibility for initial access and proper fit rests with the Contractor. Final arrangement of equipment and service connections shall allow the unit to be serviced, including space to pull motors, change fuses, and operate switches. Minimum working clearances shall be as required by NEC and local codes.

1.06 COORDINATION

- A. Contractor shall coordinate with all other trades to avoid conflicts and interferences. No extra compensation will be allowed for changes made necessary due to interference between work of various trades.
- B. Any discrepancies noted in these contract documents or discrepancies between Drawings and actual field conditions shall be promptly brought to the Engineer for a decision. No extra compensation will be allowed for changes made by the Contractor without Engineer's consent.
- C. Carefully check and coordinate each device location and elevation. Also check routing of all conduits for conflicts with structures, mechanical piping, ducts, etc. to avoid conflicts.

1.07 REGULATORY REQUIREMENTS

- A. Electrical work, including connection to electrical equipment integral with mechanical equipment, shall be performed in accordance with the latest published regulations of the National Electrical Code (NEC), State and local codes, and according to the latest Institute of Electrical and Electronic Engineers (IEEE); American National Standards Institute (ANSI); American Society for Testing and Materials (ASTM); Insulated Cable Engineers Association (ICEA); National Electrical Manufacturers Association (NEMA) Standards; and the latest published regulations of the Federal Occupational Safety and Health Act (OSHA). When applicable, the material used in the performance of the electrical work shall be listed by the Underwriters' Laboratories, Inc. (UL) for the class of service for which they are intended.

- B. Control panels shall be assembled and wired by a UL 508A recognized panel shop. All control panel components shall be UL recognized or ground fault protected per UL 508A fabrication standards. Each control panel assembly shall be fabricated according to UL 508A Standards and shall bear a serialized UL 508A label.

1.08 WARRANTY

- A. In addition to specific warranties required by the Specifications, the Contractor shall leave the entire installation in complete working order and free from defects in materials, workmanship or finish. Contractor shall repair or replace at his own expense any part that may develop defects due to faulty material or workmanship during the tests and within a period of one year after the work is accepted by the Engineer and Owner. Contractor shall repair or replace existing equipment and work that is damaged during the repair of defective apparatus, materials or workmanship.
- B. All manufacturer's warranties shall be filled out in their entirety by the Contractor for the Owner using the Owner's name and address. Unless otherwise specified, equipment warranty periods will commence on date of final acceptance.

1.09 DRAWINGS

- A. **Clarity and Legibility:** For purposes of clarity and legibility, the Drawings are diagrammatic only. Drawings are not intended to show every fitting, junction, gasket or component necessary, nor every difficulty that may be encountered during installation. Conduit routing may be adjusted in the field. Size and location of equipment are drawn to scale wherever possible. Contractor shall refer to related data in all Contract Documents and shall verify this information on site.
- B. Schematic diagrams are provided to indicate the control strategy intent only. Final circuitry shall be as determined by the Contractor or his vendors. Actual wiring diagrams shall be provided by the Contractor and reviewed by the Engineer for a fully functional system as intended.

1.10 REFERENCES

- A. The specifications reference known standards and codes. Each such standard referred to shall be considered a part of the Specifications to the same extent as if reproduced therein in full. The following is a representative list of such Associations, Institutes and Societies, together with the acronym by which each is identified.

AASHTO	American Assoc of State Highway and Transportation Officials
AIEE	American Institute of Electrical Engineers
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IES	Illumination Engineering Society

NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NETA	National Electrical Testing Association
NFPA	National Fire Protection Association
NTUA	Navajo Tribal Utility Authority
UL	Underwriter's Laboratories, Inc.

- B. Every reference in the Specifications shall mean the latest printed edition of each in effect at the Contract Date.

1.11 UTILITY SERVICE

- A. Contractor shall contact NTUA to provide or remove electrical service(s) to the site. This includes the permanent as well as any temporary service requirements. The Contractor shall provide all necessary labor and material required to obtain this service(s) in accordance with utility requirements. Any utility company fees and charges associated with providing, maintaining and usage of these services shall be paid by Owner.
- B. Submit copies of electrical service entrance equipment to NTUA for approval prior to releasing switchgear for fabrication. A copy of this approval letter shall be submitted to the Engineer.

1.12 ABBREVIATIONS

- A. References on the Drawings to various abbreviations have been made. The following is a representative list of such abbreviations together with the acronym by which each is identified.

AFF	Above finished floor
AFG	Above finished grade
AI	Analog input
AO	Analog output
ATS	Automatic transfer switch
C	Conduit
C/B	Circuit Breaker
CKT	Circuit
CPT	Control power transformer
Cu	Copper
DI	Digital input
DIST	Distribution
DO	Digital output
DWG	Drawing
GND	Ground
GFCI	Ground Fault Circuit Interrupter
GFI/GFP	Ground Fault Indication/Protection
GRS	Galvanized Rigid Steel Conduit
HPS	High Pressure Sodium
IMC	Intermediate Metal Conduit
INST	Instrument

LED	Light Emitting Diode
MBJ	Main bonding jumper
MCB	Main Circuit breaker
MCC	Motor Control Center
MCP	Motor Circuit Protector
MFR	Manufacturer
MLO	Main Lug Only
NC	Normally Closed
NO	Normally Open
NTUA	Navajo Tribal Utility Authority
PC	Personal computer
PLC	Programmable logic controller
PR	Pair
REQ'TS	Requirements
RTU	Remote terminal unit
SES	Service entrance section
SPD	Surge Protective Device
RMC	Rigid Metal Conduit (GRS or IMC)
RVSS	Reduced Voltage Soft Starter
SWBD	Switchboard
TSP	Twisted Shielded Pair
TST	Twisted Shielded Triad
VFD	Variable frequency drive
WP	Weatherproof

****END OF SECTION****

SECTION 16110

RACEWAYS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Metallic and non-metallic wiring raceways.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data demonstrating compliance with this specification including couplings, fittings, bushings, and hangers.
- B. Submit on the proposed method for separating conduits in underground ductbanks.

1.03 QUALITY ASSURANCE

- A. Perform work in accordance with NECA Standard of Installation and NFPA 70.

1.04 RELATED WORK

- A. Specification Section 16195, Electrical Identification

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Conduit:
 - 1. Rigid metal, intermediate and EMT:
 - a. Allied
 - b. Republic
 - c. Triangle Conduit and Cable Co.
 - d. Wheatland
 - 2. PVC coated rigid steel:
 - a. Ocal
 - b. Robroy
 - c. Calbond
 - d. Gafco Green
 - 3. Flexible and flexible water-tight:
 - a. Alflex Corp.
 - b. Carlon Products Corp.
 - c. Carol Cable Co., Inc.
 - d. Electri-Flex
 - e. Sealtite
 - 4. Non-metallic PVC:
 - a. Can-Tex

- b. Carlon
- c. PW Eagle/JM Eagle
- 5. Conduit supports and hangers:
 - a. Caddy
 - b. Thomas and Betts
 - c. Appleton
 - d. Crouse-Hinds
 - e. B-Line Systems
- 6. Supporting Channel:
 - a. G-Strut
 - b. Unistrut
 - c. B-Line

2.02 MATERIALS

- A. Metallic Conduit:
 - 1. Rigid steel:
 - a. Hot dipped galvanized rigid steel; meet ANSI C80.1 and ASTM A153; UL labeled and meet UL Standard No. 6.
 - b. All fittings shall be threaded. Threadless couplings shall not be used unless specifically approved by the Engineer.
 - c. All conduit body covers shall be secured with machine screws threaded onto the conduit body. Covers secured by snaptight or wedge-nuts are unacceptable.
 - d. Where PVC coated rigid steel conduit is indicated on the Drawings, the conduit shall be galvanized steel with a factory installed PVC coating. All conduit fitting, boxes, connectors, etc. shall also be PVC coated by the factory.
 - e. No aluminum conduit shall be permitted unless approved by the Engineer.
 - 2. Intermediate: Shall be same as rigid above with thinner wall.
 - 3. Electrical metallic tubing (EMT or Thin-wall) shall be:
 - a. Galvanized; meet ANSI C80.3; UL labeled; marked with manufacturer's name.
 - b. Thin-wall conduit fittings for damp or wet locations shall be of the regular watertight design, with hexagonal nuts and center portions requiring the use of a wrench during installation.
 - c. Setscrew type fittings are not permitted under any circumstances.
 - 4. Flexible conduit:
 - a. UL-listed flexible rubber or plastic coated metallic type with watertight ferrule and sleeve type connectors. Standard steel type flexible conduit is unacceptable.

- b. ANSI/NEMA FB1 steel connectors. Connectors must be PVC coated where installed in corrosive environments or where PVC conduit or PVC coated GRS conduit is specified.
 - c. Flexible conduit installed in hazardous classified areas shall be explosion-proof or be rated for use in the specified area classification.
- B. Non-Metallic PVC Conduit:
- 1. Rigid non-metallic conduit Polyvinyl Chloride (PVC) type II PVC shall be schedule 40, suitable for use with 90 degree rated wire. Conduit shall bear UL labels for above and below ground use.
 - 2. All PVC conduit 1-1/4 inch and larger with bends greater than 45° shall utilize factory bends.
 - 3. Where the enclosure or raceway is subject to physical damage, conductors shall be installed in rigid metal conduit, intermediate metal conduit, Schedule 80 rigid nonmetallic conduit or equivalent.
 - 4. Meet UL standard #651.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. General:
- 1. Raceways shall be concealed, where possible, unless otherwise indicated on the Drawings. When exposed, confirm the exact routing with the Engineer prior to roughing in.
 - 2. Sizing: Minimum conduit sizes are indicated on the Drawings. The Contractor may choose to install larger conduit for ease of installation or wiring pulling at no additional cost to the Owner. If conduit or raceway size is not indicated on the Drawings, raceways shall be sized per NEC. Unless otherwise indicated, minimum conduit size shall be 3/4 - inches.
 - 3. Unless otherwise indicated, all exposed conduits shall be galvanized steel rigid metal conduit (RMC) or intermediate metal conduit (IMC). All direct buried or concrete encased conduits to be Schedule 40 PVC.
- B. Conduit:
- 1. Conduit shall: Have openings temporarily plugged, using “pennies” or equal, to exclude plaster or other foreign materials; be reamed after cutting; have joints cut square, and butt solidly into fittings; have the ends terminated in a proper bushed fitting, be rigidly supported so as to prevent undue stress or strain on the couplings and connectors; be swabbed before conductors are pulled in.
 - 2. Concealed conduits shall be run in a direct line with long sweep bends and offsets. Horizontal runs shall be run with a slight incline, to prevent low spots or pockets (for drainage).

3. Conduits shall be continuous from outlet to outlet, from outlets to cabinets, pull or junction boxes and shall be secured to boxes with lock nuts and bushings in such a manner that each system shall be electrically continuous throughout. “Erickson” couplings shall be used where required. No running threads shall be cut.
4. Install conduit systems completely before conductors are pulled. Conduits shall be securely supported at proper intervals to structures with steel clamps, or conduit hangers or by special supporting assemblies when indicated on the Drawings.
5. Conduit terminations shall contain insulated bushings. Provide grounding type bushings where steel conduit is stubbed into nonmetallic enclosures, stubbed up in the base of freestanding enclosures or where locknuts cannot assure proper ground continuity between metallic enclosures and the steel conduit. Provide service entrance and transformer connection conduits with grounding type bushings.
6. Exposed conduits shall be installed parallel to walls, floor and ceilings or at right angles to the building lines. Exposed bends shall be used only where approved. Covers shall be secured to bodies with machine screws.
7. Electrical metallic tubing (EMT) or “Thin-wall” may not be used except where specifically indicated on the Drawings or as directed by the Engineer.
8. Hickey bends shall not be used for 1-inch and larger conduits. Either manufactured elbows or bends fabricated in a bending machine shall be used. The radius of the inner edge of bends shall be six times the internal diameter of the conduit for conduit sizes up to 2 ½-inches and 12 times internal diameter for 3-inches conduits and larger. A run of conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than 360° of total bends.
9. Conduit shall not be run above or below water piping, and must be individually supported.
10. In wet locations, and in locations where walls are frequently washed, the entire conduit system, including boxes and fittings used, shall be installed and equipped to prevent water from entering conduit. Conduit shall be so mounted so that there is at least ¼-inch air space between conduit and wall or similar supporting surface.
11. Schedule 40 PVC conduit may be used for buried conduit installations as permitted by the NEC and local codes except where galvanized rigid steel is specified. Couplings, transition fittings, adhesives, primer and installation procedures recommended by the conduit manufacturer and all applicable codes must be strictly followed.
12. Install liquid-tight flexible metal conduit at motors, transformers and equipment which are subject to vibration or require movement for maintenance purposes. Provide necessary reducer where equipment

furnished cannot accept 3/4-inch size flexible conduit. Limit flexible conduit length to 3-foot maximum.

- C. Sleeves, Inserts, etc.: Lay out and install work in advance of the laying or pouring of floors and erection of walls. Furnish and install sleeves that may be required for openings through floors, wall, etc. Where plans call for conduit to be run exposed, furnish and install inserts and clamps for the supporting of conduit. If this Contractor does not properly install sleeves and inserts required, he will be required to do the necessary cutting and patching later, at his own expense, to the satisfaction of the Engineer.
- D. Installation of Underground Conduits:
1. Install underground conduit as indicated on the Drawings. Backfill material around the conduits must be clean-fill (dirt with rocks no larger than 1/2-inch).
 2. Conduit bends shall have long sweep radius curves instead of standard elbows where indicated on the Drawings. All PVC conduit bends greater than 45° shall be factory-made for conduits larger than 1-inch.
 3. All underground PVC conduit shall be buried a minimum of 24-inches below finished grade, except when located below a concrete slab or freestanding electrical equipment. Conduit shall be installed deeper than 24-inches wherever required to avoid existing piping, tunnels, or other obstructions.
 4. Underground conduits in ductbanks shall be separated and supported with pre-manufactured plastic chairs, unless submitted and approved otherwise, installed at 5-foot intervals in the trench.
 5. ***After duct is in place, notify the Engineer prior to backfill for inspection.*** Failure to do so will result in removal of all backfill material to expose the conduits for inspection.
 6. During backfill, provide plastic warning tape at 12-inches below finished grade over underground electrical installations which reads, "Caution - Buried Electrical Line Below".
 7. Any portion of the conduit with less than 24-inches of cover shall be PVC coated rigid metal conduit or galvanized rigid metal conduit wrapped with 20-mil rubber tape half-lapped to a thickness of 40-mils. PVC conduits are permitted to be stubbed up directly into freestanding electrical enclosures.
 8. Where terminating PVC conduit in a freestanding enclosure, underground junction box, manhole/handhole or other similar locations, provide each termination with a bell end.
 9. Rigid metal conduit terminations shall contain insulated bushings. Provide grounding type bushings where steel conduit is stubbed into nonmetallic enclosures, stubbed up in the base of freestanding enclosures or where locknuts cannot assure proper ground continuity between metallic enclosures and the steel conduit. Install grounding type bushings on all service entrance and utility transformer connection conduits.

10. Spare conduits shall be capped with an approved plug.
11. Before pulling cables into underground conduits, pull a mandrel ¼-inch smaller than the conduit inside diameter and pulled through each conduit, and if any concrete or obstructions are found, the Contractor shall remove them and clear the conduits. Underground conduits shall be swabbed before cables are pulled in.
12. After duct runs are completed and set, backfill the trenches and tamp thoroughly to 90 percent compaction.

3.02 CONDUIT MARKERS

- A. All conduits with conduit designations indicated on the Drawings shall be identified at each termination. See Section 16195 - Electrical Identification for conduit tag requirements.

****END OF SECTION****

SECTION 16120
WIRES AND CABLES
(600V OR LESS)

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Cables and wires rated 600 volts or less, as specified, including wiring of all devices.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data on all power, signal and communication cables demonstrating compliance with this Specification.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards:
1. NFPA 70 (NEC)
 2. UL listing for materials.
 3. ICEA S-66-524
 4. NEMA WC-7
 5. ASTM B-3 or B-8

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Cable:
1. General Cable
 2. Okonite
 3. Southwire
 4. Encore
- B. Connectors:
1. Ideal
 2. Burndy Corp.
 3. Thomas and Betts Co.
 4. O.Z. Gedney
 5. Minnesota Mining & Manufacturing (3M)

2.02 MATERIALS

- A. Conductors for wire and cable shall be stranded copper with 98 percent conductivity and shall be tinned or untinned in accordance with established standards for the type of insulation around the conductors. Solid conductors are not acceptable.

- B. Wire and cable shall be stamped approximately every two feet to indicate voltage, type, temperature rating, and other significant data or warnings.
- C. Conductors for general purpose wiring shall meet the following requirements:
 - 1. Power: Type XHHW-2. Minimum conductor size for power shall be No.12 AWG.
 - 2. Control: Type XHHW-2 for conductors run in conduit, minimum size No.14 AWG. Type MTW for conductors contained in control panels, minimum size No.14 AWG or No.16 AWG when protected by an overcurrent device of 10A or less.
- D. Wire Pulling Lubricant: Lubricant shall be UL listed and be of a consistency that will not leave an obstruction or tackiness that prevents pulling out wires in the future. No soap flakes or vegetable soaps will be permitted. Lubricant in shall be Ideal Wire Lube or equal.
- E. Cable Ties: Wiring in panels, cabinets, etc. shall be neat and tied with “Ty-Rap” T&B “TY-5418” series, or Panduit Co. “Cable Wrap”. Cable ties used in outdoor locations shall be UV stabilized.
- F. Terminations:
 - 1. 3-M Scotchlok lugs and connectors - copper.
 - 2. O-Z solderless connectors, grounding devices, power connectors, armored cable fittings, and cable terminations.
 - 3. Burndy - copper - all types as appropriate for cable size and configuration.
- G. Connector material shall be compatible with conductor material to prevent corroding, differences in coefficients of expansion or electrolysis.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Install wires and cables in NEC approved raceways (Section 16110). All wire and cable must be installed in a raceway, unless otherwise indicated on the Drawings.
- B. Branch circuit and feeder conductors shall have insulation with the following color. Phase tape is unacceptable.
 - 1. Grounding conductor-Green.
 - 2. Neutral - White.
 - 3. 120/240V Phase A - Black.
 - 4. 120/240V Phase B - Red.
 - 5. 120/208V Phase A - Black.
 - 6. 120/208V Phase B - Red.
 - 7. 120/208V Phase C - Blue.
 - 8. 277/480V Phase A - Brown.
 - 9. 277/480V Phase B - Orange.
 - 10. 277/480V Phase C - Yellow.

- C. 6-inch minimum loops shall be provided at each outlet, device or luminaire. Unused wires in outlet boxes, shall be rolled up, connected together and taped or capped with wire nuts. Mark bundled, unused spare wires as “SPARE FROM [origination]”.
- D. Branch circuit sizing: Where wire size is not indicated on the Drawings, NEC and local codes shall govern. However, minimum branch circuit conductor size shall be No. 12 AWG.
- E. Pulling Cables: Wires and cables shall be carefully handled during installation. Lubricant used for pulling in wires and cables shall be used. Use a dynamometer when pulling conductors by mechanical means.
- F. Bending radius: Do not exceed the manufacturer’s maximum bending radius.

3.02 SPLICES AND TERMINATIONS

- A. Splices:
 - 1. Splices in conductors shall not be used unless otherwise indicated on the Drawings or approved by the Engineer.
 - 2. Where splices are allowed or necessary, they shall be mechanically strong and well made so that the electrical resistance of a joint shall not exceed that of 2-feet of the conductor.
 - 3. Splices shall be made only in junction boxes and never in conduit.
 - 4. Above Grade Splices:
 - a. Utilize wing nut solderless connectors for splicing No. 8 AWG and smaller conductors. Follow manufacturer’s recommendations for sizing, stripping, twisting, etc.
 - b. Utilize insulated butt connectors crimped end-to-end for splicing No. 6 AWG and larger conductors. Follow manufacturer’s recommendations for sizing, stripping and crimping.
 - 5. Below Grade Splices:
 - a. Utilize waterproof splice kits or wing nut solderless connectors with cast-resin waterproofing for splicing No. 8 AWG and smaller conductors. Follow manufacturer’s recommendations for sizing, stripping, twisting, etc.
 - b. Utilize insulated butt connectors crimped end-to-end with cast-resin waterproofing for splicing No. 6 AWG and larger conductors. Follow manufacturer’s recommendations for sizing, stripping and crimping.
 - c. Utilize insulated butt connectors crimped end-to-end for all below grade splices or No. 6 AWG and larger conductor splices above grade. Follow manufacturer’s recommendations for sizing, stripping and crimping.
- B. Motor terminations: Ring type, crimped connectors shall be installed on all conductors and bolted together back-to-back. For terminations with No.6 and smaller wire, use 10-24 bolts. Use bolts that match the connector bolthole size for

all other motor terminations. Apply one layer of cambric tape followed by three layers of rubber tape and finally, top with one layer of black vinyl tape.

- C. Non-motor terminations: Use ring or fork type, crimped connectors for all screw-on terminations. Wrapping wire around a binding post is unacceptable.
- D. Where special tools are required to properly install the particular connector the special tools must be used.

3.03 WIRE MARKERS

- A. All conductors shall be labeled at each termination and splice. See Section 16195 - Electrical Identification for wire marker requirements.

****END OF SECTION****

SECTION 16130

BOXES

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Outlet boxes, pull and junction boxes and underground junction boxes.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data for standard outlet boxes up to six gang, including floor type demonstrating compliance with specification requirements and Drawings.
- B. Shop Drawings: Submit drawings for special pull, outlet, and junction boxes demonstrating compliance with NEC and specification requirements. Drawings shall indicate box dimensions and locations in building.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards:
 - 1. NEMA 250
 - 2. NFPA 70
 - 3. UL listing for materials.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Appleton Electric
- B. Crouse-Hinds
- C. Killark
- D. Raco
- E. Hoffman Engineering Co.
- F. O.Z. Gedney Co.
- G. Steel City
- H. Hubbell
- I. Rittal

2.02 MATERIALS

- A. Outlet boxes for concealed conduits and flush-mounted wiring devices shall meet the following requirements:

1. Stamped, one piece, galvanized steel.
 2. Proper size and shape for conduits entering them.
 3. UL listed for their application.
 4. ANSI/NEMA OS-1 for galvanized steel; ANSI/NEMA OS-2 for non-metallic.
- B. Outlet boxes for exposed conduit systems and exterior locations shall be of the threaded-hub, cast-metal, conduit type fitting suitable for the wiring devices to be installed. Covers (blank, switch, receptacle, etc.) shall be the type specifically designed to fit the specified boxes.
- C. Above grade electrical junction and pull boxes shall be sheet metal with an ANSI 61 gray color with size and type as indicated on the Drawings. NEMA rating shall be as indicated on the Drawings. Where a NEMA rating is not indicated, outdoor boxes shall be NEMA 3R and indoor boxes shall be NEMA 12. Box sizes shall be as indicated on the Drawings. Where sizes are not indicated or larger size is required to meet code, the box size shall be increased as required by the National Electrical Code.
- D. Wireways:
1. Wireways shall be sized as indicated on the Drawings or as required by the National Electrical Code. Where sizes are not indicated or larger size is required to meet code, the wireway shall be sized such that the cross-sectional area of the wireway at any one point does not exceed 40% per the National Electrical Code.
 2. Cover: Hinged with removable latches where feasible.
 3. UL listed for steel enclosed wireway or auxiliary gutter.
 4. Furnished complete with covers, elbows, tees, junction boxes, end covers, connectors and hangers.
 5. Unless otherwise indicated, wireways shall be NEMA 3R.
 6. Wireways in outdoor locations shall be fully gasketed.
- E. Underground junction boxes:
1. Construction: Electric underground junction boxes shall be precast concrete and size as indicated on the Drawings. Underground junction boxes shall have precast concrete extensions.
 2. Covers: Covers shall be rectangular, reinforced concrete and have the text "ELECTRIC" cast into the cover.
 3. Approved Manufacturer: Christy, or equal.
- F. Fittings, hangers, fastenings, etc., shall be of material that will prevent chemical reaction between itself and conduit or device it is fastening or supporting.

PART 3 -- EXECUTION

3.01 BOX LOCATIONS

- A. Location of Boxes: In order that boxes may be placed in proper locations, the Contractor shall familiarize himself with the details of these spaces and carefully lay out boxes so that the equipment or piping of other trades passing under, over, across or in close proximity to same, will not cause these boxes to be inaccessible for use or maintenance. Contractor shall consult with other Contractors and trades on the project and obtain details of the project to locate outlet boxes properly.
- B. Contractor shall be responsible for the exact and proper location of the various portions of his work. Consult the Drawing and details.
- C. Mounting Heights: The exact mounting height of each switch, receptacle, light fixture outlet, etc., shall be confirmed on the premises in conference with the Engineer. Unless otherwise indicated, receptacles to be mounted at 18-inches and light switches to be mounted at 42-inches above finished floor/grade.

3.02 INSTALLATION

- A. No thru-boxes shall be permitted.
- B. Boxes shall meet the following requirements:
 - 1. Proper size and shape for conduits entering them.
 - 2. Installed so that device and/or cover plates shall be tight and plumb with wall finish.
 - 3. Have unused openings closed with knock-out closures.
 - 4. Securely fastened to building or structure.
- C. Surface-mounted outlet boxes shall meet the following requirements:
 - 1. Outdoor boxes shall be cast steel or cast aluminum with threaded hubs.
 - a. Fastened with not less than two Paine, Phillips, Ackermann-Johnson, or equivalent, screw anchors and round head machine screws on brick and concrete walls or ceilings.
 - b. Under no circumstances will drilling of cast boxes be allowed.
 - c. PVC coated boxes shall be used for installations with PVC coated rigid steel conduit.
 - d. Be provided with a vapor-proof gasket in wet locations or where indicated as "WP" (weatherproof) on the Drawings.
 - e. Install a weatherproof-while-in-use cover on all outdoor receptacles.
 - 2. Bell boxes may be used for indoor applications where rigid steel or IMC conduit is required.
- D. Flush-mounted outlet boxes shall:
 - 1. Be solid ganged boxes for more than two devices.
 - 2. Contain a plaster ring to bring the wiring device attachment points within ¼-inch of the finished wall surface.
 - 3. Be installed so that device covers are tight and plumb with wall finish.

4. Be installed as close as possible to the lock side of door trim for light switches.
- E. Bracket outlets shall be level and centered on columns or above doors when installed in these locations.
- F. Pull boxes and junction boxes shall be:
1. Installed where indicated on the Drawings or where necessary to not exceed 360 degrees of conduit bends.
 2. Entirely accessible.
 3. Securely mounted to building structure independent of the conduits connected to them.

****END OF SECTION****

SECTION 16140
WIRING DEVICES

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Wiring devices such as but not necessarily limited to power receptacles and light switches.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data for each wiring device including device covers demonstrating compliance with these Specifications and UL labeling.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and standards:
 - 1. NEMA
 - 2. UL listing
 - 3. NFPA 70

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Hubbell
- B. Leviton
- C. Bryant
- D. Crouse-Hinds
- E. Pass & Seymour

2.02 MATERIALS

- A. Light switches and receptacles shall meet NEMA WD1 and WD6 standards, be UL listed and be Heavy Duty, **Industrial** Specification grade. Commercial specification grade wiring devices are not acceptable.
- B. Amperage rating of each wiring device shall match the circuit's overcurrent device amperage rating to which it is connected.
- C. Wiring devices shall have an ivory finish unless otherwise specified.
- D. Power receptacles shall be the grounded type. Furnish ground fault circuit interrupter (GFCI) type where indicated on the Drawings or as required by the NEC.
- E. All GFCI receptacles shall be listed weather-resistance (WR) type receptacles.
- F. Light switches shall be the quiet type.

- G. Wiring Device Coverplates:
1. Unless otherwise indicated, coverplates installed indoors or in control panels shall be brushed anodized aluminum.
 2. Weatherproof locations: Wiring devices installed outdoors or where identified on Drawings with “WP” shall contain a gasketed coverplate UL approved for wet locations.
 3. Where weatherproof-while-in-use coverplates are indicated on the Drawings or required by NEC, power receptacles shall be provided with a cover that is listed for “extra duty” and maintains UL approval for wet locations when a cord is plugged into the receptacle.

PART 3 -- EXECUTION

3.01 INSTALLATION/APPLICATION

- A. Devices and coverplates shall be plumb and parallel to adjacent surfaces or trim. Flush-mounted devices must be flush with finished wall surfaces and the coverplates must be tight to surfaces over which they are installed.
- B. Receptacles identified as GFCI or when required by the NEC shall have individual GFCI receptacles installed for each outlet. Installing a single GFCI receptacle and standard receptacles connected to the load side of the single GFCI receptacle is unacceptable.

3.02 FIELD QUALITY CONTROL

- A. Contractor shall verify that the openings have been properly patched around devices without damage to devices.
- B. Damaged or painted devices shall be replaced or cleaned as directed by the Engineer.

****END OF SECTION****

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 -- GENERAL

1.01 SECTION INCLUDES

- A. Nameplates and labels
- B. Wire and cable markers
- C. Conduit markers

1.02 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code.
 - 1. NEC 110-22 Identification of Disconnecting Means
 - 2. NEC 200-6 Means of Identifying Grounded Conductors
 - 3. NEC 200-10 Identification of Terminals
 - 4. NEC 210-5 Identification for Branch Circuits
 - 5. NEC 215-8 Means of Identifying Conductor with the Higher Voltage to Ground
 - 6. NEC 230-70, (B) Service Equipment, Marking
 - 7. NEC 310-11 Marking
 - 8. NEC 310-12 Conductor Identification
 - 9. NEC 400-22 Grounded-Conductor Identification
 - 10. NEC 400-23 Equipment Grounding Conductor Identification
 - 11. NEC 408-13 Panelboard circuit identification
- B. UL standard 224- Standard for Extruded Thermoplastic Insulating Tubing.

1.03 SUBMITTALS

- A. Product Data: Provide catalog data for the following:
 - 1. Wire and cable marking system
 - 2. Nameplate materials and fasteners
 - 3. Conduit markers

1.04 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

PART 2 -- PRODUCTS

2.01 NAMEPLATES AND LABELS

- A. Engraved laminated plastic nameplates with black letters on white background shall be installed on the following as a minimum:

1. Electrical distribution equipment enclosures
 2. Disconnect switches and motor controllers
 3. Control panels and cabinets
 4. Each motor controller or control panel door mounted device
 5. Major components, control relays and terminal block strips mounted on the backpanel of control panels
- B. Letter Size:
1. Use 3/8-inch letters for identifying electrical distribution equipment enclosures and other large control panels and cabinets. Use 3/16-inch letters for identifying individual control panel components (inside or out) and small control panels/enclosures.

2.02 WIRE MARKERS

- A. Manufacturer: Raychem Corporation Model ShrinkMark or equal.
- B. Description: heat shrinkable radiation cross-linked, thermally stabilized, modified polyolefin sleeves with 3:1 shrink ratio. Markers shall be UL Standard 224 recognized.
- C. Sleeves shall be smear resistant prior to shrinking and achieve mark permanency when shrunk without the need for permatizing equipment. Sleeves should achieve mark permanency when standard ballpoint pens or high-carbon content fabric ribbons are used. The markers shall be flattened and mounted on a carrier suitable for use with commercially available print equipment. Markers shall be printable on both sides. Markers shall be resistant to common industrial fluids including Freon TF, Isopropyl alcohol, and Ethylene Glycol.
- D. Locations: Each conductor at each termination and splice.
- E. Legend:
1. Power and Lighting Circuits: Branch circuit or feeder number indicated on the Drawings.
 2. Control Circuits: Control wire number indicated on approved schematics, interconnection diagrams and shop drawings.
 3. Wire numbers shall be the same at both ends of the wire.

2.03 CONDUIT MARKERS

- A. Furnish and install conduit markers on ends of each conduit run and in intermediate locations such as manholes and handholes. Conduit markers shall be 19 gauge, 1 1/2-inch diameter round brass with backfilled legend, Style #250-BL as manufactured by Seton Nameplate Corporation or equal. Marker shall identify conduit as indicated on the Drawings. If a conduit is not identified on the Drawings, the Contractor shall consult the Engineer for the proper identification.

PART 3 -- EXECUTION

3.01 NAMEPLATES

- A. Install nameplates parallel to equipment lines.
- B. Secure nameplates to the exterior of electrical equipment using UL-508A approved die and tapped stainless steel screws (APM SEELSKREW or equal).
- C. Secure nameplate to inside surface or backpanels of control panels with a permanent adhesive (Liquid Nails or equal).

3.02 WIRE MARKERS

- A. Wire markers shall be a minimum of 3/8-inches in length and placed as near as possible to the end of the wire. Orient wire marker such that the writing can be read without turning or twisting the wire.
- B. Wire numbers shall be the same at both ends of the wire.

3.03 CONDUIT MARKERS

- A. Attach markers near the end of exposed conduits with stainless steel tie-wire.
- B. Secure conduit markers to the floor using a permanent epoxy where conduits terminate in bell ends flush with finished floor in freestanding equipment.

****END OF SECTION****

SECTION 16250

DIESEL ENGINE GENERATORS

PART 1 -- GENERAL

1.01 DESCRIPTION:

- A. Section includes furnishing and installing a UL Listed, enclosed outdoor diesel engine-driven standby generators complete with all appurtenances, as indicated on the Drawings and specified herein. The standby generator supplier must be the authorized distributor for the manufacturer of the engine.

1.02 REFERENCE:

A. STANDARDS:

1. National Electrical Manufacturers Association (NEMA):
 - a. AB-1, Molded Case Circuit Breakers.
 - b. ICS, General Standards for Industrial Control and Systems.
 - c. MG-1 1978, Motors and Generators.
 - d. SG3, Low Voltage Power Circuit Breakers.
2. Institute of Electrical & Electronic Engineers (IEEE).
3. Underwriters' Laboratories, Inc. (UL-2200).
4. Diesel Engine Manufacturers Association.
5. National Fire Protection Association (NFPA):
 - a. NFPA-110, Standard for Emergency and Standby Power Systems.
6. American National Standards Institute (ANSI):
 - a. 50.5 Rotating Exciters for Synchronous Machines.
 - b. C50.12 Salient Pole Synchronous Generators and Condensers.
7. Environmental Protection Agency (EPA) 70 FR 39870

1.03 SUBMITTALS:

A. Submit the following:

1. Manufacturer's specifications, catalog data, descriptive matter, illustrations, diagrams, etc., including but not limited to engine, generator, voltage regulator, fuel tank, batteries, battery charger, exhaust system, water jacket heater, output circuit breaker, generator control panel showing compliance with this Specification Section.
2. Drawings: Outline drawing of each generator set with overall dimensions. Interconnection wiring diagrams of the generator control systems showing control connections between generator, transfer switch and auxiliary equipment. Power and control wiring conduit entrance locations. Fuel lines and connections. Base anchoring footprint drawing. Control panel layout.

3. A certificate acknowledging that the generator set will properly start and run the loads indicated on the Drawings for 16 continuous hours with the installation configuration within the CMU block walls as indicated on the Drawings.
 4. Engine generator unit prototype test report of identical size, type and construction. Generator test report shall certify the following:
 - a. Maximum output power
 - b. Maximum motor horsepower starting capacity
 - c. Fuel consumption at full load
 - d. Engine/alternator cooling air flow (heat rejection)
 - e. Transient response and steady state governing
 - f. Alternator temperature rise
 - g. Single step load pickup
 - h. Harmonic analysis indicating THD for voltage and current
 - i. Short circuit test indicating maximum current withstand
 - j. Torsional analysis
 - k. Sound level (dB) at 23 feet from unit.
- B. Factory tests on the engine generator set shall be conducted, certified, documented and submitted to the Engineer for review prior to shipment. The test shall be conducted at rated load and 0.8 power factor in accordance with NFPA Factory Test Reports. Tests shall include the following:
1. Steady-state voltage and frequency analysis
 2. Transient response
 3. Maximum power output
 4. Fuel consumption
 5. Safety shutdowns
- C. Documentation that certifies the standby generator will meet the current Environmental Protection Agency (EPA) and any other state or local emission standards for stationary compression ignition internal combustion engines.

1.04 OPERATING AND MAINTENANCE MANUALS

- A. Identify the size, model and features for each item.
- B. Furnish operating instruction manuals outlining step-by-step procedure required for system startup and operation, including manufacturer's name, model number, service manual parts list and brief description of all equipment and basic operating features. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
- C. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or

components not related to equipment furnished must be removed or crossed out. *O&M manuals must be individually tailored to the project and equipment as furnished.*

- D. Furnish maintenance instruction manuals outlining maintenance procedures, including a troubleshooting guide listing possible breakdown and repairs, and a simplified connection wiring diagram for the system.
- E. Copy of warranties issued on the installation, showing dates of expiration.
- F. Refer to Specification Section 16010 for additional requirements.

1.05 QUALITY ASSURANCE

- A. Contractor to ensure that concrete pad, conduit, conductors and branch circuit device ratings are suitable for the equipment supplied. Contractor shall coordinate with the generator set manufacturer for proper conduit stub up locations prior to installation.
- B. Contractor shall review the installation of the generator and all related equipment as indicated on the Drawings with the generator manufacturer's representative prior to submittal or shop drawing preparation. Any concerns with the installation as designed shall be brought to the attention of the Engineer immediately. Failure of the generator to operate properly due to confinements of the installation, whether by design or not, will be corrected by the Contractor at no cost to the Owner.
- C. The generator set manufacturer shall be responsible for and guarantee that the standby generator will operate at full load for 16 hours continuous at the location indicated on the Drawings. Any upgrading of components or modifications to the generator set required for proper operation (larger radiator, remote mounted radiator, fuel cooler, air intakes/ventilation, louvers, etc) shall be done at no cost to the Owner.
- D. The standby generator shall meet the latest Environmental Protection Agency (EPA) emission standards adopted by the authority having jurisdiction in the location where this generator will be installed.
- E. Where required by the EPA, State or other authority having jurisdiction, the Contractor shall be responsible for obtaining an Air Quality Permit for the Owner to operate the standby generator. The permit shall be obtained from the Arizona Department of Environmental Quality and/or any other authority having jurisdiction. The permit shall be filled out in the Owners name. Permit cost will be reimbursed by the Owner.

1.06 WARRANTY AND SERVICE

- A. A manufacturer's warranty shall be furnished on all components, parts, assemblies and performance of the generator against defects in materials and workmanship for a period of 2-years from the date of shipment. Warranty shall include parts, labor and travel expenses.

- B. The equipment manufacturer must have a local service center within a 400-mile radius of the project site with stocked spare parts and staffed with trained, full-time employees who are capable of performing testing, inspecting, repair, and maintenance services.

1.07 MANUFACTURERS

- A. Caterpillar Tractor Co., Peoria, IL
- B. Cummins Power Systems, Minneapolis, MN
- C. Generac Power Systems, Waukesha, WI

PART 2 -- PRODUCTS

2.01 GENERAL

- A. The engine, generator and all associated equipment as specified herein shall provide standby power during periods of normal power failure from utility.
- B. The engine-generator set shall consist of one engine and one generator.
- C. The engine-generator set shall be mounted on a structural steel frame or skid. Vibration isolators suitable to prevent transmission of vibration to the concrete pad shall be provided between the set and the frame.
- D. The engine-generator set shall have a minimum standby power KW rating as indicated on the Drawings at 0.80 power factor. Apply all temperature and elevation derating as necessary to verify that the minimum generator KW ratings indicated are correct.
- E. The generator shall operate at a speed not to exceed 1,800 rpm, and have an output voltage and phasing to match that of the *Normal* source.
- F. Instantaneous voltage dip for all possible sequences of load application and motor starting for loads described in conditions of service shall not exceed 30 percent of nominal voltage. Instantaneous voltage dip for step starting the loads as indicated below shall not exceed 30 percent of nominal voltage.
- G. Frequency regulation shall be isochronous from no load to rated load.
- H. Voltage regulation from no load to rated load shall have cyclic variations in RMS voltage not to exceed +/- 1.0 percent and a speed variation not to exceed +/- 5.0 percent of rated speed.

2.02 GENERATOR:

- A. Generator shall be rated for standby duty; shall be a 4-pole rotating field, engine-driven, direct-connected, synchronous type with amortisseur windings. Generator frame shall be dripproof with all openings guarded. Bearings shall be a single, prefabricated, sealed ball type.
- B. Generator insulation shall be Class H in accordance with NEMA Standard MG1-1.65 and BS2757. 125°C temperature rise at standby power rating.

- C. The AC generator, voltage regulator and exciter shall be designed and manufactured by the generator set manufacturer.
- D. Voltage regulator shall be an automatic, temperature compensated, solid-state type with a manual adjustment range of plus or minus 5 percent of rated voltage. The voltage regulator shall be equipped with 3-phase RMS sensing, overvoltage and overexcitation protection. Overvoltage and overexcitation protection features shall latch requiring the generator to be shutdown for reset.
- E. Exciter shall be brushless with full-wave silicon diodes mounted on the rotating shaft with a surge suppresser connected parallel with the field winding. Exciters utilizing field discharge resistors is not acceptable. Minimum rating of exciter shall be as indicated in NEMA Std. MG-1-22.16.
- F. Fast acting fuses or other protective devices shall be incorporated where failure of regulator or exciter components could result in damage to the generator field or exciter windings.
- G. Voltage regulator and static exciter shall be mounted in generator control panel or elsewhere so as to protect from and isolate from vibration.
- H. Generator and exciter shall conform to all applicable requirements of NEMA Standards, Publication MG1-1987, for Motors and Generators. Generators and exciters shall also conform to ANSI Standards C50.5, Rotating Exciters for Synchronous Machines and C50.12 Salient Pole Synchronous Generators and Condensers, as applicable.
- I. A permanent magnet generator (PMG) shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by nonlinear SCR controlled loads on the generator. The PMG shall sustain main field excitation power for optimum starting and to sustain short circuit current for selective operation and coordination of system overcurrent devices.
- J. Generator lead terminal box shall be of sufficient size to accept and terminate conductors as indicated on the Drawings. Field terminations to the generator leads shall be furnished with the proper terminal lugs suitable for the conductor size(s) as indicated on the Drawings.

2.03 DIESEL ENGINE

- A. Heavy-duty compression-ignition, cold-starting diesel type arranged for direct connection to an alternating current generator. It shall be a current model of a type in regular production by a manufacturer regularly engaged in building this type of diesel engine.
- B. Engine shall have at least a published intermittent brake horsepower rating at specified generator speed required by generator at rated full load output and shall operate without undue heating, vibration, or wear.
- C. Engine shall be four-cycle and may be naturally aspirated, or scavenged.
- D. Engine shall operate on *low sulfur* No. 2 diesel fuel oil.

- E. An electronic governor consisting of a speed sensor, adjustable electronic control and an actuator to provide automatic isochronous generator set frequency control.
- F. Performance, materials, and workmanship shall be in accordance with Diesel Engine Manufacturers Association standard practices.

2.04 FUEL STORAGE SYSTEM

- A. Provide a double-wall fuel tank with spill containment under the structural steel base. As a minimum the tank shall incorporate threaded pipe connections for fuel level gauge, fuel leak detection, low fuel level sensor, fuel suction line, fuel return line, vent, drain and a 1" spare port. Leak detection and a low fuel level sensor shall be pre-wired to the generator control panel with dry contacts for remote monitoring.
- B. Tank shall have capacity to operate generator at full load for 24-hours minimum.
- C. **Tank design shall be such that gauges, control panel and operating mechanisms (circuit breaker handle, emergency stop button, keyed switch, etc) are not located more than 72-inches above the concrete pad.**

2.05 ENGINE FUEL SYSTEM

- A. Diesel fuel system shall consist of an engine-driven, positive displacement fuel supply pump, fuel filters, and a secondary contained fuel piping system.
- B. Fuel filters shall be replaceable without breaking any fuel line connection or disturbing fuel pumps or any other part of engine. Oil filters shall be conveniently located ahead of injection or circulating pump so that fuel is thoroughly filtered before it reaches injectors. Screens or filters requiring cleaning or replacement shall not be used in injection or circulating pump, or in injection valve assemblies.
- C. Water separators shall be furnished to separate the water from the diesel fuel. A probe to detect water in the diesel fuel shall be provided to activate the Generator Failure/Malfunction alarm when the presence of water is detected in the fuel.

2.06 ENGINE COOLING SYSTEM

- A. The generator set shall be supplied with a closed-loop, skid-mounted radiator with a belt-driven fan and integral jacket water circulating pump.
- B. Provide radiator of sufficient capacity to operate the engine generator set at full load in 100°F ambient temperature at site elevation for 16 consecutive hours.
- C. Provide water jacket heater(s) to provide positive water circulation, thermostatically controlled to operate between 100 and 120°F. Voltage shall be 120V for 2kW and below or 240V, 1Ø for heaters over 2kW. Heater shall be equipped with a power cut-off relay and shutoff valves at both inlet and outlet sides.

2.07 ENGINE LUBRICATION

- A. Provide full pressure system, supplying oil to all surfaces requiring lubrication. Circulation shall be by positive displacement pump. Full flow-type filters or filters with bypass feature shall be included. Filter elements shall be replaceable without disconnecting oil piping. Provide an oil cooler, if recommended by engine manufacturer, to properly lubricate engine at full rated generator load.

2.08 ENGINE APPURTENANCES

- A. Furnish engine with following appurtenances:
 - 1. Combustion air cleaner of oil bath type or dry replaceable filter type. A tube shall connect crankcase breather with air cleaner to prevent accumulation of objectionable smoke and fumes.
 - 2. Exhaust silencers for residential silencing complete with drains and flexible stainless-steel connection. Design and provide exhaust piping system, including seismic analysis, vibrations isolators, expansion joints.
 - 3. Exhaust piping shall be steel with flexible connections. The exhaust piping shall include a condensation trap(s) with drain valve(s) to prevent water from entering the engine. An exhaust rain cap and all necessary fittings shall be provided on the stack outlet.
- B. The generator set shall be supplied with a molded case, thermal magnetic type main circuit breaker, mounted and wired. Voltage and amperage shall be as indicated on the Drawings. Amperage Interrupting Capacity (AIC) shall match or exceed maximum RMS symmetrical short circuit current available from the generator during a bolted phase-to-ground fault.

2.09 ENGINE ELECTRICAL SYSTEM:

- A. Electrical system shall include batteries, electric starter, voltage and current-regulated charging generator or alternator, and a separate battery charger. Both a manual starting switch and fully automatic starting from a remote pilot device shall be furnished.
- B. Batteries and starter shall be of suitable capacity to start engine through three starting cycles of 10 seconds each. If the generator has not started after three starting cycles, it shall be shutdown automatically until manually reset.
- C. Battery charger shall be automatic, two rate type providing for equalizing charge and continuous taper charging. Output characteristics shall match requirements of battery furnished. Provide charger suitable for operation on 120 volt, single-phase, 60-Hertz current to be rated not less than 10-amp direct current. Furnish battery charger with following features:
 - 1. Direct current voltage regulation: plus or minus 2 percent for variations in line voltage of plus or minus 10 %.
 - 2. Direct current voltmeter and direct current ammeter, each with suitable scales.
 - 3. Automatic surge suppresser.

4. Automatic current limiting to prevent overloading due to engine cranking, shorted output or reversed battery connections.
 5. Alternating current line fusing.
 6. Built-in equalize charge timer.
 7. Integral protection to prevent battery discharge through charger on loss of alternating current line voltage.
 8. Set of normally open dry contacts to close on Low Battery Alarm.
- D. Provide battery rack with battery hold-down clamps to accommodate starting batteries within the generator enclosure.

2.10 CONTROL PANELS

- A. The generator set shall be provided with a microprocessor based control system to provide automatic starting, monitoring and control functions for the generator set. The control panel shall be UL 508A labeled and manufactured by the generator manufacturer specifically for the generator set supplied.
- B. The control panel shall be mounted on the generator with vibration isolators. The maximum height above grade or viewing platform to the center of the highest digital display or meter shall not exceed 66". Where the control panel digital display mounting height exceeds this, it shall be reinstalled by the generator manufacturer **or** the Contractor shall fabricate a steel framed 36" x 36" viewing platform with aluminum grating and stairs at no cost to the Owner.
- C. Control panel doors and all door-mounted devices shall be gasketed and dust-tight. All remote control and monitoring signals shall be terminated on terminal blocks.
- D. The control panel shall be provided with the following controls/meters:
1. RUN/OFF/AUTO selector switch (3-position switch or keypad)
 2. Mushroom head, maintained EMERGENCY STOP pushbutton
 3. ALARM RESET pushbutton
 4. PANEL LAMP pushbutton to illuminate controls and meters
 5. Voltmeter
 6. Ammeter
 7. Frequency meter
 8. Kilowatts (kW)
- E. The following status and alarms shall be displayed on the digital display panel:
1. Engine Oil Pressure (psi)
 2. Low Oil Pressure Alarm
 3. Engine Coolant Temperature (°F)
 4. High & Low Coolant Temperature Alarms
 5. Overcrank Alarm

6. Overspeed Alarm
 7. High & Low DC Voltage Alarms
 8. Low Fuel Alarm
 9. High & Low Output Voltage Alarms
 10. Under frequency Alarm
 11. Overload/Overcurrent Alarm
 12. Ground Fault Alarm
 13. Engine Speed (RPM)
 14. Running Time (hours)
 15. Battery Voltage (DC Volts)
- F. The control system shall include a ground fault monitoring relay with an adjustable time delay for alarm. The ground fault relay shall be used for alarm monitoring only, not to trip the main circuit breaker, unless otherwise indicated.
- G. Form “C” dry contacts shall be provided for remote monitoring of alarms as indicated on the Drawings. The contacts shall be rated 2A at 30 VDC, minimum.

2.11 OUTDOOR WEATHERPROOF ENCLOSURE

- A. Provide a weatherproof enclosure for the engine, and associated components.
1. Enclosure shall include an updraft duct with bird screen on the radiator end to direct the generator’s discharge air upward.
 2. Enclosure to have fully gasketed doors for access to all portions of the generator that requires any maintenance. All doors to have rain molding above door opening, stainless steel hinges and a two point latch to allow the doors to be completely removed. Handles to be the key locking type.
 3. As a minimum, the enclosure roof, walls and doors shall contain 1/2” deep support ribs with 16 gauge minimum exterior steel with interior sound attenuation insulation. Insulation shall consist of minimum #6 density wool held in place with a perforated liner.
 4. All seams shall be caulked with a sealer prior to painting. Paint exterior surfaces of equipment with two coats of acceptable oil and heat-resistant paint, applied after surfaces have been thoroughly cleaned and prepared with suitable priming coat. **Exterior color shall be desert tan unless otherwise directed by the Owner.**
 5. Provide fixed louvers with a screened cover over air openings sized as required for proper airflow.
 6. The enclosure shall have a steel base channel constructed to drop *over* the generator set with anchor boltholes for fastening to the generator frame or concrete slab.

PART 3 -- EXECUTION

3.01 COORDINATION

- A. Coordinate with ventilation, fuel supply, and exhaust, to provide an efficient, well coordinated layout.

3.02 INSTALLATION

- A. Install unit complete and make operational.
- B. Install muffler(s) horizontally above the unit.
- C. Provide ½-inch (12mm) copper drain with draincock on bottom of muffler to nearest drain for periodic draining of muffler.
- D. Provide vibration isolation of exhaust equipment to prevent transfer of vibration into building components.
- E. Provide vibration isolators suitable to prevent transmission of vibration from the generator frame to the concrete pad or building floor. Securely anchor the generator frame to the concrete pad/floor with galvanized anchor bolts shall be furnished by engine-generator set manufacturer. Obtain from supplier of engine-generator set a drawing giving location and size of foundation bolts for unit proposed, in sufficient time to be available when needed to place foundation.
- F. Electrical equipment and materials shall be listed by UL wherever standards have been established by that agency.

3.03 WIRING AND CONNECTIONS

- A. Provide conduit, wiring, and connections required and recommended by generator supplier. All conduit and fuel line stub-ups shall be contained within the generator set frame.
- B. Connect generator frame to the electrical service grounding system as indicated on the Drawings. The generator neutral conductor shall be run to the service entrance equipment isolated from ground via the automatic transfer switch and bonded to the service equipment neutral bus.
- C. For 3Ø, 3W standby power supply: Install a main bonding jumper (MBJ) between the generator neutral and the generator ground bus/frame. Size as indicated on the Drawings for the service entrance section.
- D. For 1Ø, 3W standby power supply: Do not install a main bonding jumper (MBJ) between the generator neutral and ground bus/frame. If the generator is furnished with a MBJ, the Contractor shall remove it before conducting any standby power system testing. The neutral conductor shall be run to the service entrance equipment isolated from ground via separate terminals in the automatic transfer switch and bonded to the service equipment neutral bus.

3.04 TESTING

- A. On-site Tests:
 - 1. Unless certified in the factory test report, the generator manufacturer must pressure test the fuel line and the secondary containment piping in

accordance with the Uniform Fire Code and any applicable Local, State, or Federal requirements.

2. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown and return to normal. Record the time to achieve standby power after loss of the *Normal* power source. Record the time to retransfer back to the *Normal* power source.
3. Verify fuel tank is full, then provide a full load test for the aeration system standby generator utilizing a portable resistive load bank, for eight (8) hours. Full load shall be the kVA as indicated on the generator set nameplate. Supply all fuel and portable test bank required for testing.
 - a. Record in 20 minute intervals during the on-site test:
 - 1) Time of Day
 - 2) Kilowatts
 - 3) Amps
 - 4) Voltage
 - 5) Coolant temperature
 - 6) Air temperature
 - 7) Frequency
 - 8) Oil pressure
 - 9) Battery charging rate
 - b. Test all alarm and shutdown circuits by simulating fault or failure conditions.
 - c. Refill fuel tank after full load test is complete and record the volume of fuel required to refill the tank.

3.05 TRAINING

- A. Operator training shall be provided by the generator manufacturer's factory-trained representative.
- B. The training shall be conducted at the project site.
- C. The training session shall include up to four Owner's representatives.
- D. The training session shall be a minimum of four (4) hours, conducted on a normal workday as decided upon by the Owner.
- E. The training session shall include the proper maintenance and operation of the standby generator and automatic transfer switch.

****END OF SECTION****

SECTION 16260

AUTOMATIC TRANSFER SWITCH

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Automatic transfer switches, 600V and below with accessories as indicated herein.

1.02 REFERENCE:

- A. STANDARDS:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. ICS, General Standards for Industrial Control and Systems.
 - 2. Institute of Electrical & Electronic Engineers (IEEE).
 - 3. Underwriters Laboratory (UL) 1008
 - 4. National Fire Protection Association (NFPA):
 - a. NFPA-110, Standard for Emergency and Standby Power Systems.

1.03 SUBMITTALS:

- A. Submit the following:
 - 1. Product Data: Provide catalog data on all components in accordance with this specification.
 - 2. Drawings: Interconnection wiring diagrams for the generator control systems indicating control connections between the generator and automatic transfer switch. Power and control wiring conduit entrance locations.

1.04 OPERATING AND MAINTENANCE MANUALS

- A. Identify the size, model and features for each item.
- B. Furnish operating instruction manuals outlining step-by-step procedure required for system startup and operation, including manufacturer's name, model number, service manual parts list and brief description of all equipment and basic operating features. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
- C. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or components not related to equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
- D. Furnish maintenance instruction manuals outlining maintenance procedures, including a troubleshooting guide listing possible breakdown and repairs, and a simplified connection wiring diagram for the system.

- E. Copy of warranties issued on the installation, showing dates of expiration. Warranty period shall begin at date of substantial completion.
- F. Refer to Specification Section 16010 for additional requirements.

1.05 QUALITY ASSURANCE

- A. Contractor to ensure that conduit size and wire quantity, size, and type are suitable for the equipment supplied.
- B. Comply with the following Codes and Standards:
 - 1. UL listing and labeling for materials.
 - 2. UL 1008
 - 3. NFPA-70.

1.06 WARRANTY AND SERVICE

- A. A manufacturer's warranty shall be furnished on all components, parts, assemblies and performance of the transfer switch for a period of 2-years from the date of substantial completion. Warranty shall include parts, labor and travel expenses.
- B. The equipment manufacturer must have a local service center within a 400-mile radius of the project site with stocked spare parts and staffed with trained, full-time employees who are capable of performing testing, inspecting, repair, and maintenance services.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. ASCO
- B. Russelectric
- C. Zenith
- D. Or equal

2.02 MATERIALS

- A. The transfer switch shall be provided with ratings, number of poles/wires and installed as indicated on the Drawings. The short circuit withstand ampacity shall meet or exceed the indicated AIC rating of the electrical equipment immediately connected to the load side of the transfer switch. The transfer switch shall be capable of switching all classes of loads while under full load.
- B. The transfer switch shall be mounted in an empty section of the distribution switchboard as indicated on the Drawings.
- C. Load transfer shall be delayed transition, three position (center off) electrically and mechanically interlocked contactors. Interlocked circuit breakers are not acceptable.

- D. Main switch contacts shall be silver or have silver alloy surfaces, arcing tips and arc extinguishing devices. Transfer switch shall be capable of closing on an inrush current 20 times its full load rating without contact damage and capable of withstanding a system short circuit fault until the overcurrent device trips. Total transfer time in either direction shall not exceed one-half second. Interlock *Normal* and *Emergency* contactors both mechanically and electrically so that both cannot be closed at any one time.
- E. Switching contactors and cable connections shall have a transparent protective cover to protect operating personnel from accidental contact and allow visual determination of the transfer switch position.
- F. The transfer switch shall be provided with a door mounted, 3-position selector switch or keypad with password for TEST, NORMAL and RETRANSFER manual transfer control which will activate the transfer switch with the same contact-to-contact speed as automatic operation.
- G. There shall be a separate adjustable time delay (0-2 min.) for transferring power from the *Normal* to *Emergency* and retransferring back.
- H. As a minimum, the transfer switch shall be provided with the following:
1. Open transition type controls necessary for a delay in transfer.
 2. Temperature compensated, solid-state voltage sensors shall simultaneously monitor all phases of both normal and standby power sources. Transfer from *Normal* to *Emergency* source shall occur when the *Normal* source voltage and frequency drops below an adjustable 85-95 percent nominal for a period of time as set by the time delay to transfer (0-2 minutes). Retransfer back to *Normal* shall occur when the *Normal* source has been restored to nominal an adjustable 85-95 percent for a period of time as set by the time delay to retransfer (0-30 minutes).
 3. An adjustable time delay (0-5 seconds) with a suitable contact for starting an engine generator upon loss of *Normal* power.
 4. Transfer of power to the standby source shall occur within 10 seconds of loss of *Normal* power.
 5. 250V, 10A, Form "C" auxiliary and control contacts as follows:
 - a. Two contacts that are closed when the transfer switch is in the *Normal* position.
 - b. Two contacts that are closed when the transfer switch is in the *Emergency* position.
 6. After retransfer of power from a standby generator source, the generator shall remain running for an adjustable time period as set by a timing relay (0-10 minutes).
 7. Separate pilot lights to indicate the presence of each source and transfer switch position.

8. Separate status indicators to indicate the presence of each power source, signal to start engine generator, transfer/retransfer timing, transfer/retransfer complete and stop generator timing.
9. Full rated lugs for *Normal*, *Emergency* and *Load* conductors as indicated on the Drawings.
10. Terminal blocks for all control and monitoring field-wiring connections as indicated on the Drawings and as specified herein.
11. A 7-day, 24-hour adjustable exerciser clock or, if indicated on the Drawings, a remote start/stop input shall be capable of exercising the generator set under *No Load* condition.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Install where indicated on plans. Mount unit such that it is level and plumb.
- B. Aeration System ATS: The Contractor shall coordinate with the switchboard manufacturer to provide adequate space and installation of the automatic transfer switch. Connections to the utility and load sides of the automatic transfer switch shall be bussed with copper bus by the switchboard manufacturer.
- C. Prior to installation, coordinate with other trades to verify conduits have adequate space to leave and enter the switch enclosure and for required code clearance. A minimum working clearance as defined by the NEC 110-26 shall be provided.
- D. Install in accordance with NFPA 70 and all applicable local codes and regulations.

3.02 TESTING

- A. Factory Tests:
 1. Provide factory production tests in accordance with NEMA standards and NFPA standard 110. Check and set all instruments and safety devices.
- B. On-site Tests:
 1. Simulate utility power failure to verify proper operation of the automatic transfer switch, automatic starting and stopping of the standby generator and retransfer back to utility when utility power is resumed. Record the time to achieve standby power after loss of the *Normal* power source. Record the time to retransfer back to the *Normal* power source.
 2. Verify all status and alarm signals being monitored remotely.
 3. Coordinate with the Owner for programming the exerciser clock settings.

3.03 TRAINING

- A. The Contractor shall provide training by a manufacturer's factory-trained representative.
- B. The training shall be conducted at the project site.

- C. The training session shall include up to four Owner's representatives.
- D. The training session shall be a minimum of two (2) hours, conducted on a normal workday as decided upon by the Owner.
- E. The training session shall include the proper maintenance and operation of the automatic transfer switch.

****END OF SECTION****

SECTION 16400
FREESTANDING
SERVICE ENTRANCE SECTION

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Freestanding electrical service entrance section and service disconnect.

1.02 SUBMITTALS

- A. Product Data: Submit catalog cuts and manufacturer's descriptive literature for approval for:
1. Service Entrance Sections
 2. Service Disconnect
- B. Shop Drawings:
1. Submit drawings showing dimensions and dimensional clearances within the structure.
 2. Include metering, ground fault protection, if required; breaker/fusing, dimensioned bus locations, digital metering and instrument transformers.
 3. Submit single line diagram and any associated schematic and wiring diagrams for equipment in the service and distribution equipment.
 4. All electrical characteristics (voltage, phasing, amperage, bracing, interrupting capacity).
- C. Serving electric utility company coordination:
1. The Contractor shall submit the above listed information to the serving utility company for approval of proposed service entrance equipment. The Contractor shall submit written approval from the serving utility company to the Engineer.

1.03 QUALITY ASSURANCE

- A. Meet requirements of NEC (NFPA 70)
- B. Codes and Standards:
1. NFPA 70-NEC
 2. NEMA
 3. U.L. listed
 4. ICEA
 5. IEEE
 6. ANSI
 7. Local utility company

- C. Service equipment shall bear markings “Suitable for Use as Service Equipment” or be UL listed as “Service Equipment.”
- D. The manufacturer of the service entrance equipment shall be the manufacturer of the circuit protective devices, and other accessories within.
- E. The manufacturer of the service entrance equipment shall be ISO 9000, 9001 or 9002 certified.
- F. The manufacturer of the service entrance equipment shall have produced similar electrical equipment for a minimum period of five (5) years. If requested by the Engineer, a list of installations with successful operation of similar equipment shall be provided demonstrating compliance with this requirement.

1.04 RELATED WORK

- A. Section 16195 – Electrical Identification
- B. Section 16425 – Distribution Switchboards

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Eaton
- B. Schneider
- C. General Electric Co.
- D. Siemens

2.02 GENERAL CONSTRUCTION

- A. The equipment specified herein shall have the following ratings:
 - 1. Voltage: As indicated on the Drawings
 - 2. Phasing: As indicated on the Drawings
 - 3. Alternating Current Frequency: 60 Hz
 - 4. Bus Bracing: As indicated on the Drawings
 - 5. Bus Amperage: As indicated on the Drawings
 - 6. Protective Device Mounting: Fixed
 - 7. Enclosure: Freestanding, NEMA 3R
- B. The service equipment shall consist of the required number of vertical sections bolted together to form a rigid assembly. The internal components and bussing shall be completely enclosed with dead front construction. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.
- C. All sections of the equipment shall be rear aligned. All protective devices shall be group mounted. Devices shall be front removable and load connections front accessible enabling assembly to be mounted against a wall.

- D. All bus bars shall be silver or tin plated copper. Main horizontal bus bars shall be mounted with all phases arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria of 65°C over a 40°C ambient (outside of the enclosure).
- E. Provide a full capacity neutral bus.
- F. An appropriately sized copper ground bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the assembly. Ground conductors shall be attached to the bus by means of mechanical type lugs.
- G. All hardware used on conductors shall be high-tensile strength and zinc plated. All bus joints shall be provided with conical spring type washers.
- H. Small wiring, necessary fuse blocks and terminal blocks within the assembly shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
- I. Mechanical type terminals shall be provided for all line and load terminations suitable for copper cable rated for 75°C.
- J. Assembly shall be furnished with an underground incoming line section as indicated on the Drawings and a separate barriered-off utility metering compartment complete with hinged sealable door(s). Bus work shall include provisions for mounting utility company current transformers and potential taps or transformers as required. Lugs shall be provided in the incoming line section for connection of the serving utility's cables.
- K. Provide stamped steel manufacturer's master nameplate(s) on the exterior door that identifies the assembly's designation, voltage, phasing, amperage, short circuit rating, manufacturer's name, general order number and item number. Secure nameplate(s) to exterior door using stainless steel, self-tapping screws.
- L. All exterior and interior steel surfaces of the assembly shall be properly cleaned and provided with a rust-inhibiting phosphatizing coating. Color and finish shall be ANSI 61, unless noted otherwise.

2.03 CIRCUIT BREAKER TYPE PROTECTIVE DEVICES

- A. Circuit breakers shall be of the molded case type.
- B. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy, and arc extinction shall be accomplished by means of arc chutes.
- C. Circuit breakers shall have a minimum symmetrical interruption capacity as indicated on the Drawings.

- D. Circuit breakers shall be equipped with a microprocessor-based sensing trip unit with the following features as a minimum:
1. Each tripping system shall consist of three current sensors, a trip unit, and a flux transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection function. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached.
 2. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
 3. The microprocessor-based trip unit shall have thermal memory capabilities to prevent the breaker from being reset following an overload condition until after a preset time delay.
 4. When the adjustable instantaneous setting is omitted, the trip unit shall be provided with an instantaneous override. Internal ground fault protection adjustable pick-up ratings shall not exceed 1200 amperes. Provide neutral ground fault current sensor for four-wire loads.
 5. Breakers shall have built-in test points for testing the long time delay, instantaneous, and ground fault functions of the breaker by means of a 120 volt operated test set. Provide one test set capable of testing all breakers 400 A frame and above.
 6. System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments: Long time pick-up and delay; Short time pick-up and delay with selective curve shaping; Instantaneous pick-up; Ground fault pick-up and delay with selective curve shaping.
- E. The Contractor shall be responsible for the setting of the adjustable protective parameters of the circuit breakers to ensure proper system protection and coordination.

2.04 ARC FLASH WARNING LABEL

- A. Furnish each service entrance section with an Arc Flash Warning label to read:

“WARNING
Arc Flash and Shock Hazard
Appropriate (PPE) Required”

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. The Contractor shall provide the services of a qualified and certified factory-trained manufacturer's representative as necessary for assistance in the installation and start-up of the equipment specified herein. The representative shall provide technical direction and assistance in making adjustments and testing of the equipment.
- B. Furnish and install service entrance equipment as indicated on the Drawings, in accordance with the serving utility's requirements, in accordance with the NEC and all applicable local codes and regulations.
- C. Install main bonding jumper and provide grounding of service entrance equipment per the NEC, serving utility and applicable local code requirements.
- D. Before energizing, perform the following tasks:
 - 1. Remove all scraps of wire, dust, dirt and any other foreign material.
 - 2. Inspect the switchgear for proper installation as recommended in the manufacturer's installation instructions furnished with the gear. Inspect all bus bolts and cable connections to insure that they are tight and terminated properly. Inspect all overcurrent devices for damage and look for components that may have loosened during shipment.
 - 3. Meggar testing: Open all overcurrent devices and remove all instrumentation and control fuses. Use a megohmmeter developing 500 volts to test the switchgear. A minimum of 100-megaohms of resistance must be measured from each phase to ground. Any readings less than this will require the manufacturer to inspect the switchgear and replace or make the necessary repairs.

****END OF SECTION****

SECTION 16401
WALL-MOUNTED
SERVICE ENTRANCE SECTION

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Wall-mounted electrical service entrance sections consisting of utility metering and service disconnect.

1.02 SUBMITTALS

- A. Product Data: Submit catalog cuts and manufacturer's descriptive literature for approval for:
 - 1. Service Entrance Section
- B. Shop Drawings:
 - 1. Submit drawings showing dimensions and dimensional clearances within the structure.
 - 2. Include metering per serving utility requirements and main circuit breaker.
 - 3. All electrical characteristics (voltage, phasing, amperage, bracing, interrupting capacity).
- C. Serving electric utility company coordination:
 - 1. The Contractor shall submit the above listed information to the local serving utility for approval of proposed service entrance equipment. The Contractor shall submit written approval from the local utility to the Engineer.

1.03 QUALITY ASSURANCE

- A. Meet requirements of NEC (NFPA 70)
- B. Codes and Standards:
 - 1. NFPA 70-NEC
 - 2. NEMA
 - 3. U.L. listed
 - 4. ICEA
 - 5. IEEE
 - 6. ANSI
 - 7. Local Utility Company
- C. Service equipment shall bear markings "Suitable for Use as Service Equipment" or be UL listed as "Service Equipment."
- D. The manufacturer of the service entrance equipment shall be the manufacturer of the circuit protective device, and other accessories within.

- E. The manufacturer of the service entrance equipment shall be ISO 9000, 9001 or 9002 certified.
- F. The manufacturer of the service entrance equipment shall have produced similar electrical equipment for a minimum period of five (5) years. If requested by the Engineer, a list of installations with successful operation of similar equipment shall be provided demonstrating compliance with this requirement.

1.04 RELATED WORK

- A. Division 16, Electrical

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Sun Valley Electric
- B. Milbank
- C. Eaton
- D. Schneider
- E. Or equal

2.02 GENERAL CONSTRUCTION

- A. The equipment specified herein shall have the following ratings:
 - 1. Voltage: As indicated on the Drawings
 - 2. Phasing: As indicated on the Drawings
 - 3. Alternating Current Frequency: 60 Hz
 - 4. Bus Bracing: As indicated on the Drawings
 - 5. Bus Amperage: As indicated on the Drawings
 - 6. Protective Device Mounting: Fixed
 - 7. Enclosure: NEMA 3R, surface mounted as indicated on the Drawings.
- B. The service equipment shall consist of an assembly furnished with an incoming line section (overhead or underground as indicated on the Drawings) and a separate barriered-off utility metering compartment complete with hinged sealable door(s). Bus work shall include provisions for mounting utility company current transformers and potential taps or transformers as required by utility. Lugs shall be provided in the incoming line section for connection of the feeder conductors.
- C. The internal components and bussing shall be completely enclosed (metal clad) with dead front construction. All edges of front covers or hinged front panels shall be formed.
- D. All bus bars shall be silver or tin plated copper.
- E. Provide a full capacity neutral landing lug or bus if a three phase, four wire or single phase, three wire system is indicated on the Drawings.

- F. Mechanical type terminals shall be provided for all line and load terminations suitable for copper cable rated for 75°C.
- G. All exterior and interior steel surfaces of the assembly shall be properly cleaned and provided with a rust-inhibiting phosphatizing coating. Color and finish shall be ANSI 61, unless noted otherwise.

2.03 CIRCUIT BREAKER TYPE PROTECTIVE DEVICES

- A. Circuit breakers shall be of the molded case type and shall provide overcurrent protection with inverse time and instantaneous tripping characteristics.
- B. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy, and arc extinction shall be accomplished by means of arc chutes.
- C. Circuit breakers shall have a minimum symmetrical interruption capacity as indicated on the Drawings
- D. Circuit breakers shall have thermal magnetic trip units and inverse time-current characteristics.
- E. The Contractor shall be responsible for the setting of the adjustable protective parameters of the circuit breakers to ensure proper system protection and coordination.

2.04 ARC FLASH WARNING LABEL

- A. Furnish each service entrance section with an Arc Flash Warning label to read:

“WARNING
Arc Flash and Shock Hazard
Appropriate (PPE) Required”

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Furnish and install service entrance equipment as indicated on the Drawings, in accordance with the serving utility’s requirements, in accordance with the NEC and all applicable local codes and regulations.
- B. Install main bonding jumper and provide grounding of service entrance equipment per the NEC, serving utility and applicable local code requirements.

END OF SECTION

SECTION 16425

DISTRIBUTION SWITCHBOARDS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Distribution switchboards and related equipment.

1.02 SUBMITTALS

- A. Shop Drawings: Submit drawings showing dimensions, construction and materials. Include specific information for each piece of equipment including, but not limited to, the following items:
 - 1. Distribution Switchboard
 - 2. Surge Protective Device (SPD)
- B. Product Data: Submit manufacturer's data on switchboards including the following:
 - 1. Voltage characteristics.
 - 2. Number of phases.
 - 3. Frequency.
 - 4. Short-circuit and continuous current ratings.
 - 5. Main and branch overcurrent device sizes and A.I.C. ratings.
 - 6. Section dimensions.
 - 7. Bussing.
 - 8. Insulation level.
 - 9. Type of labels and labeling for every device and what it feeds.

1.03 RELATED WORK

- A. Section 16195 – Electrical Identification
- B. Section 16261 – Automatic Transfer Switch
- C. Section 16400 – Freestanding Service Entrance Section
- D. Section 16461 – Transformers (Dry-Type)
- E. Section 16470 – Panelboards
- F. Section 16475 – Overcurrent Protective Devices

1.04 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (refer to Section 16010):
 - 1. NFPA 70 (NEC)
 - 2. NEMA PB-2
 - 3. UL 891 and be UL listed.
 - 4. ICEA

5. IEEE
6. ANSI

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Schneider
- B. General Electric Co.
- C. Eaton
- D. Siemens

2.02 SWITCHBOARDS

- A. Construction:
 1. Switchboard shall be assembled with the service entrance section as a continuous bussed structure including the automatic transfer switch.
 2. Switchboards shall be furnished with group mounted overcurrent protective devices, automatic transfer switch, panelboard and transformer. Refer to other Specifications Sections contained in Division 16 for additional information.
 3. Switchboard shall contain the required number of vertical sections bolted together to form one metal-enclosed switchboard not more than 90-inches high. Sides, top and rear covers shall be code gage steel, bolted to the switchboard structure. The frame structure members shall be die-formed steel bolted together and reinforced at external corners with rugged gussets internal and external to the structure members.
 4. Enclosure shall be NEMA 3R, freestanding for installation outdoors as indicated on the Drawings.
 5. Vertical sections comprising the switchboard shall be rear-aligned.
 6. Furnish with adequate lifting means, and be capable of being rolled or moved into installation position and bolted directly to the floor without the use of floor sills.
 7. Provide stamped steel manufacturer's master nameplate(s) on the exterior door that identifies the assembly's designation, voltage, phasing, amperage, short circuit rating, manufacturer's name, general order number and item number. Secure nameplate(s) to exterior door using stainless steel screws, APM SEELSKREW or equal
- B. Devices:
 1. Provide switchboard with devices as indicated on the Drawings. Each device shall have a quick-make, quick-break externally operated handle that can be locked in "on" or "off" position.
- C. Bus Bars:

1. The automatic transfer switch shall be bussed from the service disconnect and to the distribution switchboard bussing. All bus bars shall be copper, nested in individual extruded channels in a fiberglass base, to provide a barrier between phases. Bus joints shall be bolted with high tensile steel bolts. Bus joints shall be accessible from the rear of the switchboard for maintenance.
2. Bus bars shall be braced to withstand short circuit mechanical forces of not less RMS symmetrical amps as indicated on the Drawings.
3. Current density of the phase and neutral busses shall not exceed 1,000 amperes per square inch cross-section. Continuous current rating of the bus shall be equivalent to the switch size rating of the main device(s).
4. Feeder device line and load connection straps shall be rated to carry the full continuous current rating of the device switch (not trip rating). Load connection straps shall be insulated and extended beyond the main bus.
5. Ground Bus: Furnish not smaller than ¼ in. x 2 in. copper ground bus secured to each vertical section structure, and extended the entire length of the switchboard.
6. Bus Arrangement: A-B-C type bus arrangement (left- to-right, top-to-bottom, front-to-rear) shall be used throughout to assure convenient and safe testing and maintenance.

D. Wiring:

1. Internal Interlocking and Control Wiring: Fuse blocks and terminal blocks are to be furnished as required within the switchboard. Group control wires leaving the switchboard with terminal blocks and numbered terminal strips.
2. Lugs: Cable connectors shall be mechanical type tin- plated and U/L listed for aluminum or copper cables. See Section 16120.

E. Finish:

1. Steel surfaces shall be chemically cleaned and treated, providing a bond between paint and metal surfaces to help prevent the entrance of moisture and formation of rust under the paint film. Switchboard exterior is to be finished with ANSI61 light gray paint.

2.03 SURGE PROTECTIVE DEVICE (SPD)

A. The switchgear shall be furnished with an SPD specifically designed for mounting in the switchboard. The unit shall have the following features and functions:

1. UL 1449, 3rd Edition listed
2. UL 1283 listed
3. Minimum Surge Current Rating shall be as indicated on the Drawings.
4. Modes of protection: L-L, L-G, L-N, N-G
5. The maximum UL listed voltage protective rating (VPR) for each mode of protection shall not exceed the following:

<u>Mode</u>	<u>277/480</u>
Line-Neutral	<u>1200</u> VAC
Line-Ground	<u>1200</u> VAC
Neutral-Gnd	<u>1200</u> VAC
Line-Line	<u>2000</u> VAC

6. Status pilot lights, Form C relay contact, EMI/RFI filtering (50dB noise attenuation from 10kHz to 100MHz), and surge counter
 7. Minimum 10 year warranty
- B. Acceptable manufacturers:
1. Schneider Surgelogic Series
 2. Eaton PSPD Series
 3. Siemens TPS3 Series
 4. Or equal

2.04 ARC FLASH WARNING LABEL

- A. Furnish distribution switchboard with an Arc Flash Warning labels on each section to read:

“WARNING
Arc Flash and Shock Hazard
Appropriate (PPE) Required”

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Install switchboards in strict accordance with manufacturer’s instructions.
- B. Provide sections for the automatic transfer switch, panelboard and transformer as indicated on the Drawings. These sections shall be assembled by the switchboard manufacturer and conform to other Specifications Sections contained in Division 16. Coordinate with vendors of other equipment for proper size of each section.
- C. Install the panelboard and SPD behind inner doors (panels). These inner doors (panels) shall be hinged and able to be opened without the use of tools.
- D. Before energizing, perform the following tasks:
 1. Remove all scraps of wire, dust, dirt and any other foreign material.
 2. Inspect the switchboard for proper installation as recommended in the manufacturer’s installation instructions furnished with the gear. Inspect all bus bolts and cable connections to insure that they are tight and terminated properly. Inspect all overcurrent devices for damage and look for components that may have loosened during shipment.
 3. Meggar testing: Open all overcurrent devices and remove all instrumentation and control fuses. Use a megohmmeter developing 500 volts to test the switchgear. A minimum of 100-megohms of resistance

must be measured from each phase to ground. Any readings less than this will require the manufacturer to inspect the switchgear and replace or make the necessary repairs.

****END OF SECTION****

SECTION 16450

GROUNDING

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Grounding and bonding of electrical equipment, raceways and specialized systems, including testing.

1.02 SUBMITTALS

- A. Manufacturer's data for the following:
 1. Connection methods
 2. Ground rods
 3. Ground rod wells

1.03 SYSTEM DESCRIPTION

- A. Ground electrical equipment, conduits, supports, cabinets, and switchgear in accordance with NFPA 70 (NEC) and as shown on the Drawings, the intent being a system ground and an equipment ground.

1.04 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (refer to Section 16010):
 1. IEEE 81-1962--IEEE Recommended Guide for Measuring Ground Resistance and Potential Gradients in the Earth.
 2. NFPA 70 (NEC)
 3. NEMA
 4. UL listing
 5. MIL Handbook 419

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Ground Rods:
 1. Anderson Electric Corp.
 2. Copperweld Corp.
 3. Harger

2.02 MATERIALS

- A. Ground rods shall be copperclad rods $\frac{3}{4}$ -inch in diameter and 10-feet long unless indicated otherwise on the Drawings.
- B. Ground rod wells shall be $8\frac{1}{2}$ -inch diameter constructed of reinforced concrete with a reinforced concrete removable cover stamped "GROUND" as manufactured by Christy or equal.

- C. Connectors, mechanical lugs or wire terminals shall be used only to bond ground wires, junction and panel boxes.
- D. Grounding conductors shall be stranded copper, size as indicated on the Drawings or as required by the NEC. Grounding conductors shall be bare or contain green insulation.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Where mechanical lugs are not welded or fastened with a threaded bolt, surfaces shall be thoroughly cleaned and paint scraped to bare metal before connections are made to insure good metal-to-metal contact.
- B. An equipment grounding conductor must be installed in each conduit with power conductors or, in the case of multi-conductor cable, run inside the cable sheath.
- C. The Contractor shall bond the electrical equipment pad rebar to the service grounding electrode system.
- D. A main system ground, bare copper conductors, size as indicated, shall be run in PVC conduit from the service entrance section to the grounding electrode system as indicated on the Drawings.
- E. Connections to ground rods shall be exothermically welded. Ground rod connections shall be done in a ground rod well for inspection purposes. Ground rod connections may also be done with Burndy "HYTAP" type connectors.
- F. All enclosure doors with 120V mounted devices shall be bonded to the enclosure ground bus.

****END OF SECTION****

SECTION 16461
TRANSFORMERS
(DRY-TYPE)

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Dry-type transformers.

1.02 SUBMITTALS

- A. Shop Drawings: Submit shop drawings indicating outline dimensions, connection and support points, weight, specified ratings and materials, design test, UL listing, and options being provided. Show spatial relationship to adjacent equipment and structures.
- B. Product Data: Submit wiring diagram with protection and control diagram. Clearly differentiate between wiring that is factory installed and portions to be field installed.
- C. Certificates: Furnish the User's Representative with certified high potential test reports performed on each transformer winding at the manufacturer's facilities prior to transformer shipment.

1.03 QUALIFICATIONS

- A. The manufacturer of the transformer shall be the manufacturer of the distribution switchboard.

1.04 REGULATORY REQUIREMENTS

- A. All transformers shall be UL-listed and shall bear the UL label.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Eaton
- B. Schneider
- C. General Electric Co.
- D. Siemens

2.02 GENERAL PURPOSE TRANSFORMERS

- A. KVA and voltage ratings shall be as indicated on the Drawings. Six voltage taps shall be provided; two above and four below nominal voltage in 2.5% increments.
- B. Transformers shall be designed for continuous operation at rated KVA, for 24 hours a day, 365 days a year operations, with normal life expectancy as defined in ANSI C57.96.
- C. Sound Output: Sound outputs of transformers shall not exceed the following levels, based on NEMA standard testing procedures:

<u>KVA Rating</u>	<u>Decibel Sound Output</u>
0 - 9	40
10 - 50	45
51 - 150	50
151 - 300	55
301 - 500	60

- D. Insulation system: Transformers shall be insulated with a 220°C insulation system based upon 115°C rise.
- E. Required performance shall be obtained without exceeding the applicable temperature rise in a 40 degrees C maximum ambient. All insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM Standard Test Method D635.
- F. Transformer core shall be constructed with high-grade, nonaging, silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point. The transformer core volume shall allow efficient transformer operation at 10 percent above the highest tap voltage. The core laminations shall be tightly clamped and compressed. Coils shall be wound of electrical grade aluminum with continuous wound construction.
- G. External cable shall be rated 90°C for encapsulated type and 75°C for ventilated type designs. Connectors shall be provided for cable sizes as indicated on the Drawings. The core of the transformer shall be grounded to the enclosure.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Transformers shall be installed in a blank section of the distribution switchboard by the distribution switchboard manufacturer.

3.02 ADJUSTING

- A. Adjust primary taps so that secondary voltage is within 2 percent of rated voltage.

****END OF SECTION****

SECTION 16470
PANELBOARDS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Lighting and power distribution panelboards.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data demonstrating compliance with this specification and the Drawings. Information shall include but not be limited to:
1. A panel schedule indicating branch circuit number, size and type of individual circuit breakers, interrupting capacity of the device and number of poles.
 2. Short circuit current bracing of the panel.
 3. Bus material and mounting type.
 4. Demonstrate means of identification of each circuit and of each panel by mark corresponding to the Drawings. Explain any deviations.
 5. Clearly indicate all dimensions and that it has been verified that the equipment will fit into place.
 6. Indicate ground bus kits.
 7. Integral surge protective device (SPD) documentation, where applicable.
- B. Test Data: Submit test reports on integrated panel.

1.03 QUALIFICATIONS

- A. The manufacturer of the panelboard installed in the distribution switchboard shall be the manufacturer of the distribution switchboard.

1.04 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (refer to Section 16010):
1. NEMA
 2. UL listing
 3. NFPA 70 (NEC)
 4. W-P-115a Power Distribution, current edition

1.05 RELATED WORK

- A. Section 16010 – Basic Electrical Requirements
- B. Section 16195 – Electrical Identification
- C. Section 16450 - Grounding
- D. Section 16475 – Overcurrent Protective Devices

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Schneider
- B. Eaton
- C. General Electric Co.
- D. Siemens

2.02 MATERIALS

- A. Panelboards shall have the following minimum requirements:
 - 1. UL listed with copper bus bars of 98 percent conductivity and minimum cross sectional area based on UL 67 for heat rise. Bus size and ratings shall be in accordance with UL 67. Minimum bus voltage, amperage and short circuit withstand rating shall be as indicated on the Drawings or as required per NEC.
 - 2. Copper bars shall be provided for terminating equipment grounding conductors and neutral conductors, where applicable.
 - 3. Terminals shall be UL rated for use with copper or aluminum conductors.
 - 4. Panelboards shall include a main circuit breaker or solderless main lugs as indicated on the Drawings. Lugs for main lug only panelboards shall be sized to accommodate the incoming power supply conductors.
 - 5. Fully rated feed-thru lugs shall be provided where indicated.
 - 6. Branch breakers shall be the bolt-on type, unless otherwise indicated.
 - 7. A framed directory pocket shall be provided on the inside door with 1/16-inch thick glass or plastic cover and typed written directory card.
 - 8. A manufacturer's stamped steel nameplate shall be riveted to the exterior indicating voltage, amperage, phases and short circuit bracing.
 - 9. Where indicated, circuit breakers shall have a fixed handle padlock attachment capable of locking the circuit breaker in the off position.
 - 10. Enclosures shall be constructed of galvanized steel with a baked-on polyester power coated ANSI-61 light gray finish. Panelboard doors shall consist of a bolt-on steel cover with an integral hinged door for circuit breaker access (door-in-door). Unless otherwise indicated on the Drawings, NEMA ratings shall be as follows:
 - a. Indoor flush mounted: NEMA 1
 - b. Indoor surface mounted: NEMA 12
 - c. Outdoor: NEMA 3R, gasketed with tamperproof screws
 - 11. Three phase panelboards shall have a minimum of 5-inch wide top and bottom gutters and 6-inch side gutters. Power distribution panelboards may be larger to accommodate larger branch breakers or subfeed breakers.

2.03 SURGE PROTECTION DEVICE (SPD)

- A. Where indicated, panelboards shall be furnished with an integral Type 2 SPD specifically designed for installation in the panelboard. The unit shall have the

following features and functions:

1. ANSI/UL 1449 Third Edition.
2. UL 1283 listed for high frequency noise.
3. UL 845 listed for motor control centers.
4. All modes of protection: L-N, L-G, L-L, N-G
5. The minimum Surge Current Capacity per phase shall be as indicated on the Drawings.
6. The maximum UL 1449-Third Edition VPR for the protection of each mode shall not exceed the following:

<u>Mode</u>	<u>277/480</u>	<u>120/240V</u>
Line-Neutral	<u>1200 VAC</u>	<u>700 VAC</u>
Line-Ground	<u>1200 VAC</u>	<u>1000 VAC</u>
Neutral-Gnd	<u>1200 VAC</u>	<u>700 VAC</u>
Line-Line	<u>2000 VAC</u>	<u>1200 VAC</u>
7. Status pilot lights to indicate unit is powered and operating properly. Separate pilot light(s) shall indicate unit or individual phase protection module failure.
8. Form C alarm contacts for remote monitoring unit failure.
9. Minimum 5 year warranty.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Prior to installing panelboards, verify conduits have adequate space to enter the panelboard and to provide the required code clearance. A minimum working clearance as defined by the NEC 110-26 shall be provided. Whether the panelboard is installed indoors or outdoors, the working space as defined in Table 110-26(a) of the NEC shall apply.
- B. Panelboards shall be installed such that the highest circuit breaker handle is not more than 6'-7" above finished floor.
- C. Provide a means of keeping unauthorized hands out of live panels during construction when panelboard fronts have not been installed.
- D. Complete the panelboard schedule by accurately typing in a brief load description for the appropriate circuit number. Place a copy of the panelboard schedule in the pocket of the panelboard door.
- E. Each branch circuit conductor shall be clearly identified by color as to the phase connection. Wiring in panels shall be neat with rounded corners and tied in bundles with approved ties. See Section 16120.
- F. Where a common neutral is run for more than one branch circuit, the phase conductors shall be connected to separate, consecutive phases in order that the neutral will carry only the unbalanced current in each phase. Neutral conductors

shall be same size as phase conductors unless specifically noted otherwise.

G. Surface Mounted Panelboards:

1. Shall be installed plumb and level, and in accordance with manufacturer's directions.
2. Surface mounted panelboards shall be securely bolted to the walls.

H. Distribution Switchboards Mounted Panelboards:

1. Panelboards in distribution switchboards shall be installed by the distribution switchboard manufacturer.

3.02 BALANCING

- A. Panelboard circuiting shall be as indicated on the Drawings whenever possible. Additional loads shall be placed to balance loads between phases as much as possible.

****END OF SECTION****

SECTION 16475

OVERCURRENT PROTECTIVE DEVICES

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Overcurrent Protective Devices such as fuses and circuit breakers.

1.02 SUBMITTALS

- A. Fuses: Submit catalog cuts which indicate the fuse symbol and ampere rating for each disconnect or device.
1. Submit manufacturer's data showing fuse name, symbol, voltage rating, UL class, interrupting capacity or I-squared time (I^2t) characteristics and accessories.
 2. Fuse trip curves.
- B. Breakers: Submit catalog cuts that indicate type of breaker, size, trip, characteristics, interrupting capacity, and the specified features.

1.03 OPERATING AND MAINTENANCE MANUALS

1. Identify the size, model and features for each item.
2. Complete instructions regarding the operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. *O&M manuals must be individually tailored to the project and equipment as furnished.*
3. Refer to Specification Section 16010 for additional requirements.

1.04 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (see Section 16010):
1. NFPA 70 (NEC)
 2. UL listing
 3. ANSI
 4. NEMA

1.05 RELATED WORK

- A. Division 16, Electrical

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Fuses:
1. Bussmann Mfg. Div.
 2. Gould-Shawmut
 3. Little-Fuse

- B. Circuit Breakers:
 - 1. Schneider
 - 2. Eaton
 - 3. General Electric Co.

2.02 MATERIALS

- A. Fuses:
 - 1. Fuses up to 600 volts shall meet the following:
 - a. Be of the same manufacturer.
 - b. Shall NOT be shipped in fused switches.
 - c. Shall be stored in a safe, moisture free area until needed.
 - d. All dual element fuses shall have separate overload and short circuit elements. The overload element shall include a spring-assisted thermal unit. The thermal unit shall open on a temperature rise above 280 degrees Fahrenheit. Time delay for the overload element shall be at least 10 seconds at 500 percent of rated amperes.
 - e. When indicated on the Drawings or required by the local authority or serving utility, fuses shall be silver-sand UL Class R or Class L current-limiting fuses (low-peak dual element).
 - f. Motor branch circuit fuses rated 1/10 to 600 amperes shall be sized one ampere rating above the selected heater element. Fuse ampere rating shall not exceed 175 percent of motor FLA. Abnormal motor conditions requiring increased ampere ratings shall be referred to the Engineer. Fuses shall be UL Class R current-limiting dual element with time delay.
- B. Circuit Breakers:
 - 1. Low voltage breakers up to 600 volts shall meet the following:
 - a. Be quick-make, quick-break type.
 - b. Have toggle mechanism insuring full contact pressure until time of opening whether manually or automatically operated.
 - c. Thermal magnetic type to have inverse time tripping characteristics with fixed thermal trip action to hold on harmless momentary overload.
 - d. Adjustable trip setting shall be provided for all service entrance section main circuit breakers.
 - e. A short circuit condition shall cause the magnetic trip element to instantly trip without damage or injury.
 - f. Have non-welding, non-corroding contacts.
 - g. Be full-size with mechanism enclosed in molded bake-lite case, sealed to prevent tampering or unauthorized changes in calibration.

- h. Be UL listed and recognized.
- i. Meet NEMA standards.
- j. Be bolt-on type unless otherwise specified.
- k. Have contacts that operate in a multiple plate arc-quenching chamber vented to load side of breaker - UL listed.
- l. Be rated for AIC compatible with ratings of the panel or switchboard bus they are to be used in as indicated on the Drawings. Unless otherwise indicated, series rated devices are not acceptable. All overcurrent devices shall be fully rated.
- m. Be calibrated for operation in a minimum ambient temperature of 50 degree C.
- n. All multi-pole breakers shall have common trip.
- o. For multi-pole breakers shall require the same space as the equivalent number of single pole breakers. Wafer style breakers are unacceptable.
- p. Have operating handle that visually indicates “on”, “off”, or “tripped”.
- q. Be labeled to indicate circuit number(s) and load served.
- r. Be rated for 100% continuous operation where indicated on the Drawings.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Provide overcurrent protection for all wiring and equipment in accordance with NFPA 70, State or local codes, whichever is prevailing.
- B. Should nameplate data disagree with the size or application of an overcurrent protective device indicated on the Drawings, immediately bring it to the attention of the Engineer for a decision.
- C. Place a label inside each fused switch door. Label shall indicate fuse type, ampere rating and interrupting rating. Manufacturers’ labels are acceptable.
- D. Where blank spaces or spaces designated for future overcurrent devices are indicated on the Drawings, they shall be complete with bus links.

3.02 SPARE PARTS

- A. Furnish one spare set of three (3) of each size and type of fuse rated at more than 30 amperes, and 10 percent of each size and type of fuse rated 30 amperes or less, but in no case less than one set of three (3).

****END OF SECTION****

SECTION 16500

LIGHTING

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Luminaires and lamps.

1.02 SUBMITTALS

- A. Submit manufacturer's data for the following:
1. Luminaires with designation as indicated on the Drawings.
 2. Lamps (type, color, wattage, etc.).
- B. Submit manufacturer's data demonstrating compliance with Specifications and the luminaires as indicated on the Drawings.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (see Section 16010):
1. UL listed and labeled.
 2. NEMA
 3. NFPA 70 (NEC)
 4. IES

PART 2 -- PRODUCTS

2.01 MATERIALS

- A. Luminaires shall be:
1. Furnished with proper outlet boxes, hardware, supports, canopy extensions, etc.
 2. Furnished complete with gaskets, cast aluminum weatherproof outlet box, UL Listed for wet locations, have lamp bases coated with an inhibitor to prevent base from corroding to the socket and be solidly grounded.
 3. Furnished complete with lamps with wattage and voltage as indicated on the Drawings.
 4. Furnished with specified finish and color.
- B. Lamps:
1. LED's and their driver shall be designed for minimum operational life of 50,000 hours in -20°C to 40°C ambient air temperature. The lumen output shall not decrease by more than 20% over the operational life. The driver shall decrease output power when the ambient air temperature is outside the -20°C - 40°C range instead of shutting the LED's off. The driver shall be UL listed and include a quick disconnect plug for maintenance. Kelvin temperature shall be 4000K unless otherwise indicated on the Drawings.

PART 3 -- EXECUTION

3.01 INTERFERENCES

- A. Contractor shall carefully examine the complete areas as well as each individual room where luminaires are to be installed, for interference with piping and other trades. Where such interferences occur, provide luminaires with proper type suspension to overcome such interferences.

3.02 INSTALLATION

- A. Luminaires shall be installed parallel with walls and ground for a neat appearance. Where luminaires are indicated to be mounted on a perimeter wall, luminaires shall be installed on a flush mounted box at an elevation such that the top of fixture is flush with the top of wall.
- B. Operate luminaires after installation and connection. Check for proper operation. Replace luminaires that have failed or are not functional.

3.03 OPERATION

- A. Wall mounted luminaires shall be controlled by a light switch located on the enclosure wall as indicated on the Drawings.

****END OF SECTION****

**GANADO WWTP
UPGRADE
ELECTRICAL SPECIFICATIONS
TABLE OF CONTENTS**

16010..... Basic Electrical Requirements

16110..... Raceways

16120..... Wires and Cables (600V or Less)

16130..... Boxes

16140..... Wiring Devices

16195..... Electrical Identification

16250..... Diesel Engine Generators

16260..... Automatic Transfer Switch

16400..... Freestanding Service Entrance Section

16401..... Wall-Mounted Service Entrance Section

16425..... Distribution Switchboards

16440..... Disconnect Switches

16450..... Grounding

16461..... Transformers (Dry-Type)

16470..... Panelboards

16475..... Overcurrent Protective Devices

16500..... Lighting



SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Electrical general provisions as indicated, specified and required for constructing a complete, ready for use electrical system as described in these Contract Documents.
- B. Labor, materials, apparatus, and appliances essential to the complete functioning of systems described and indicated herein, or which may be reasonably implied as essential, whether mentioned in the Contract Documents or not, shall be furnished and installed by the Contractor. In case of doubt as to the work intended, or in the event of need for explanation thereof, Contractor shall refer to the Engineer for supplemental instructions.
- C. All items not specifically mentioned in these Specifications or noted on the Drawings, or on shop drawings, but which are necessary to make a complete and satisfactory, working electrical/instrumentation installation, shall be deemed to be included herein.
- D. All electrical equipment shall be capable of operating successfully at full-rated load, without failure, at an ambient air temperature of -30°C to 50°C, and specifically rated for an altitude of 6320 feet. Where these criteria cannot be met, ancillary equipment and/or special derating factors as approved by the Engineer shall be utilized.
- E. The Contractor shall perform all necessary saw cutting, core drilling, excavating, removal, shoring, backfilling, etc as required for the proper installation of conduits whether inside or outside of the building(s) and structure(s). The Contractor shall repair and patch where demolition has taken place in a manner to match existing original structure.
- F. Since this facility is in continuous operation, the Contractor shall prepare and submit a flow chart and/or written narrative describing the sequence of construction with duration of anticipated power interruptions.

1.02 SUBMITTALS

- A. Submit documentation for review as described in individual Specification Sections for products requiring submission.
- B. Submit Division 16 in one submittal, or at a maximum, the following may be submitted as separate submittals for this project.
 - 1. Commodities (Sections 16010-16195) and Grounding (Section 16450)
 - 2. Standby Generators (16250)
- C. Documentation must be arranged in numerical sequence corresponding with each Specification Section and article of each Section. Soft copies shall be in “pdf”

format with “character recognition” and shall include the following as a minimum:

1. A cover sheet to identify the Contractor’s name, name of the project, date and description, i.e. “Division 16 – Commodities”.
 2. An index corresponding to each specification section with all addendum updates included. Each paragraph or bulleted item shall be check marked to signify compliance with each item and the information is included in the submittal package. If full compliance is not met for any reason, the non-compliance item shall be underlined and reference to a detailed written explanation of the deviation or non-compliance shall be provided in the margin to the right of the specification paragraph or bulleted item for consideration.
 3. Bookmarks within each section for each major component within.
 4. Complete manufacturer name and model number of each item. Listing items “as specified” without both make and model or type designation is not acceptable.
 5. Descriptive Data: complete description, information, and performance data covering materials and equipment that are being proposed. Each component shall be clearly identified on each sheet. Refer to individual specification sections for additional submittal requirements.
- D. If hard copies are provided, they shall be bound in 3-ring binders (2” max) and include all information as described above for soft copies. The binders shall include tabs corresponding to a neatly typewritten index. The binder cover and edge shall clearly identify the Contractor’s name, name of the project, date and submittal number.
- E. Important Notice:
1. **After material or equipment has been submitted and approved, no substitutions will be allowed. Any equipment installed that is different than the approved shop drawings and submittals will be removed and replaced at the Contractor’s expense without exception!**
 2. If Contractor's submittal(s) depart from the Contract Documents, the Contractor shall make specific mention thereof in his letter(s) of transmittal, otherwise review of such submittals by the Engineer shall not constitute review of such departure(s).
 3. The Contractor may be charged for costs incurred by the Engineer for third and subsequent submittal reviews. Cost for Engineer’s review time shall be billed at the Engineer’s standard hourly rates.

1.03 RECORD DRAWINGS AND OPERATION AND MAINTENANCE MANUALS

- A. Record Drawings: On completion of work, Contractor shall furnish a complete set of Record Drawings and Shop Drawings which properly reflect final locations and sizes of conduit, equipment fixtures, controls, etc., as actually installed.

Dimensions shall be included on the Contractor's as-built Drawings showing exact location of underground conduits.

- B. Operation and Maintenance (O&M) Manuals: Contractor shall provide O&M manuals for the 480V service entrance section, distribution switchboard, standby generators and automatic transfer switches furnished under this contract. O&M manuals must be submitted and approved before final inspection of the project so that they may be used during startup. Soft copies shall be in "pdf" format with "character recognition" and shall include the following as a minimum:
1. A cover sheet to identify the Contractor's name, name of the project, date and description, i.e. "Electrical Equipment O&M Manual".
 2. Bookmarks within each section for each major component within.
 3. Complete manufacturer name and model number of each item.
 4. Descriptive data, wiring diagrams, dimensional drawings, etc from the approved submittals/shop drawings.
 5. Complete instructions regarding the installation, operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
 6. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or components not related to equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
 7. Copy of warranties issued on the installation, showing dates of expiration.
- C. Hard copies, if provided, shall be bound in 3-ring binders (2" max) and include all information as described above for soft copies. The binders shall include tabs corresponding to a neatly typewritten index. The binder cover and edge shall clearly identify the Contractor's name, name of the project, date and identified as "Electrical Equipment O&M Manual".

1.04 QUALITY ASSURANCE

- A. The Contractor performing the electrical construction and installation shall be a reputable Contractor licensed in the State of Arizona to do electrical **commercial** construction. As a minimum, an "L-11 Commercial" license is required. If any electrical work over 600V is required, the Contractor must also be licensed to work on High Voltage Electrical and Transmission Lines.
- B. The Contractor must be located within a 400-mile radius of the project and have been in that vicinity for a minimum of five (5) years.
- C. The Contractor must have a minimum of five (5) years experience as a Contractor installing electrical systems for other water and wastewater projects of similar type, size and requirements. If requested, the Contractor must submit documentation and list of references of recent projects similar to this one.

- D. All equipment furnished shall be new and of current design. Like equipment shall be of the same manufacturer.
- E. Unless otherwise indicated, all equipment and components shall be rated for use in the environment installed. Outdoor equipment shall be weatherproof or rated for outdoor use.

1.05 SPACE REQUIREMENTS

- A. Space Requirements: In the preparation of Drawings, a reasonable effort has been made to include equipment manufacturer's recommendations. Since space requirements and equipment arrangement vary according to manufacturer, the responsibility for initial access and proper fit rests with the Contractor. Final arrangement of equipment and service connections shall allow the unit to be serviced, including space to pull motors, change fuses, and operate switches. Minimum working clearances shall be as required by NEC and local codes.

1.06 COORDINATION

- A. Contractor shall coordinate with all other trades to avoid conflicts and interferences. No extra compensation will be allowed for changes made necessary due to interference between work of various trades.
- B. Any discrepancies noted in these contract documents or discrepancies between Drawings and actual field conditions shall be promptly brought to the Engineer for a decision. No extra compensation will be allowed for changes made by the Contractor without Engineer's consent.
- C. Carefully check and coordinate each device location and elevation. Also check routing of all conduits for conflicts with structures, mechanical piping, ducts, etc. to avoid conflicts.

1.07 REGULATORY REQUIREMENTS

- A. Electrical work, including connection to electrical equipment integral with mechanical equipment, shall be performed in accordance with the latest published regulations of the National Electrical Code (NEC), State and local codes, and according to the latest Institute of Electrical and Electronic Engineers (IEEE); American National Standards Institute (ANSI); American Society for Testing and Materials (ASTM); Insulated Cable Engineers Association (ICEA); National Electrical Manufacturers Association (NEMA) Standards; and the latest published regulations of the Federal Occupational Safety and Health Act (OSHA). When applicable, the material used in the performance of the electrical work shall be listed by the Underwriters' Laboratories, Inc. (UL) for the class of service for which they are intended.

1.08 WARRANTY

- A. In addition to specific warranties required by the Specifications, the Contractor shall leave the entire installation in complete working order and free from defects in materials, workmanship or finish. Contractor shall repair or replace at his own expense any part that may develop defects due to faulty material or workmanship

during the tests and within a period of one year after the work is accepted by the Engineer and Owner. Contractor shall repair or replace existing equipment and work that is damaged during the repair of defective apparatus, materials or workmanship.

- B. All manufacturer's warranties shall be filled out in their entirety by the Contractor for the Owner using the Owner's name and address. Unless otherwise specified, equipment warranty periods will commence on date of final acceptance.

1.09 DRAWINGS

- A. Clarity and Legibility: For purposes of clarity and legibility, the Drawings are diagrammatic only. Drawings are not intended to show every fitting, junction, gasket or component necessary, nor every difficulty that may be encountered during installation. Conduit routing may be adjusted in the field. Size and location of equipment are drawn to scale wherever possible. Contractor shall refer to related data in all Contract Documents and shall verify this information on site.
- B. Schematic diagrams are provided to indicate the control strategy intent only. Final circuitry shall be as determined by the Contractor or his vendors. Actual wiring diagrams shall be provided by the Contractor and reviewed by the Engineer for a fully functional system as intended.

1.10 REFERENCES

- A. The specifications reference known standards and codes. Each such standard referred to shall be considered a part of the Specifications to the same extent as if reproduced therein in full. The following is a representative list of such Associations, Institutes and Societies, together with the acronym by which each is identified.

AASHTO	American Assoc of State Highway and Transportation Officials
AIEE	American Institute of Electrical Engineers
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IES	Illumination Engineering Society
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NETA	National Electrical Testing Association
NFPA	National Fire Protection Association
NTUA	Navajo Tribal Utility Authority
UL	Underwriter's Laboratories, Inc.

- B. Every reference in the Specifications shall mean the latest printed edition of each in effect at the Contract Date.

1.11 UTILITY SERVICE

- A. Contractor shall contact NTUA to provide or remove electrical service(s) at the site. This includes the permanent as well as any temporary service requirements. The Contractor shall provide all necessary labor and material required to obtain this service(s) in accordance with utility requirements. Any utility company fees and charges associated with providing, maintaining and usage of these services shall be paid by Owner.
- B. Submit copies of electrical service entrance equipment to NTUA for approval prior to releasing switchgear for fabrication. A copy of this approval letter shall be submitted to the Engineer.

1.12 ABBREVIATIONS

- A. References on the Drawings to various abbreviations have been made. The following is a representative list of such abbreviations together with the acronym by which each is identified.

AFF	Above finished floor
AFG	Above finished grade
AI	Analog input
AO	Analog output
ATS	Automatic transfer switch
C	Conduit
C/B	Circuit Breaker
CKT	Circuit
CPT	Control power transformer
Cu	Copper
DI	Digital input
DIST	Distribution
DO	Digital output
DWG	Drawing
GND	Ground
GFCI	Ground Fault Circuit Interrupter
GFI/GFP	Ground Fault Indication/Protection
GRS	Galvanized Rigid Steel Conduit
HPS	High Pressure Sodium
IMC	Intermediate Metal Conduit
INST	Instrument
LED	Light Emitting Diode
MBJ	Main bonding jumper
MCB	Main Circuit breaker
MCC	Motor Control Center
MCP	Motor Circuit Protector
MFR	Manufacturer
MLO	Main Lug Only
NC	Normally Closed
NO	Normally Open
NTUA	Navajo Tribal Utility Authority

PC	Personal computer
PLC	Programmable logic controller
PR	Pair
REQ'TS	Requirements
RTU	Remote terminal unit
SES	Service entrance section
SPD	Surge Protective Device
RMC	Rigid Metal Conduit (GRS or IMC)
RVSS	Reduced Voltage Soft Starter
SWBD	Switchboard
TSP	Twisted Shielded Pair
TST	Twisted Shielded Triad
VFD	Variable frequency drive
WP	Weatherproof

****END OF SECTION****

SECTION 16110

RACEWAYS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Metallic and non-metallic wiring raceways.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data demonstrating compliance with this specification including couplings, fittings, bushings, and hangers.
- B. Submit on the proposed method for separating conduits in underground ductbanks.

1.03 QUALITY ASSURANCE

- A. Perform work in accordance with NECA Standard of Installation and NFPA 70.

1.04 RELATED WORK

- A. Specification Section 16195, Electrical Identification

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Conduit:
 - 1. Rigid metal, intermediate and EMT:
 - a. Allied
 - b. Republic
 - c. Triangle Conduit and Cable Co.
 - d. Wheatland
 - 2. PVC coated rigid steel:
 - a. Ocal
 - b. Robroy
 - c. Calbond
 - d. Gafco Green
 - 3. Flexible and flexible water-tight:
 - a. Alflex Corp.
 - b. Carlon Products Corp.
 - c. Carol Cable Co., Inc.
 - d. Electri-Flex
 - e. Sealtite
 - 4. Non-metallic PVC:
 - a. Can-Tex

- b. Carlon
- c. PW Eagle/JM Eagle
- 5. Conduit supports and hangers:
 - a. Caddy
 - b. Thomas and Betts
 - c. Appleton
 - d. Crouse-Hinds
 - e. B-Line Systems
- 6. Supporting Channel:
 - a. G-Strut
 - b. Unistrut
 - c. B-Line

2.02 MATERIALS

- A. Metallic Conduit:
 - 1. Rigid steel:
 - a. Hot dipped galvanized rigid steel; meet ANSI C80.1 and ASTM A153; UL labeled and meet UL Standard No. 6.
 - b. All fittings shall be threaded. Threadless couplings shall not be used unless specifically approved by the Engineer.
 - c. All conduit body covers shall be secured with machine screws threaded onto the conduit body. Covers secured by snaptight or wedge-nuts are unacceptable.
 - d. Where PVC coated rigid steel conduit is indicated on the Drawings, the conduit shall be galvanized steel with a factory installed PVC coating. All conduit fitting, boxes, connectors, etc. shall also be PVC coated by the factory.
 - e. No aluminum conduit shall be permitted unless approved by the Engineer.
 - 2. Intermediate: Shall be same as rigid above with thinner wall.
 - 3. Electrical metallic tubing (EMT or Thin-wall) shall be:
 - a. Galvanized; meet ANSI C80.3; UL labeled; marked with manufacturer's name.
 - b. Thin-wall conduit fittings for damp or wet locations shall be of the regular watertight design, with hexagonal nuts and center portions requiring the use of a wrench during installation.
 - c. Setscrew type fittings are not permitted under any circumstances.
 - 4. Flexible conduit:
 - a. UL-listed flexible rubber or plastic coated metallic type with watertight ferrule and sleeve type connectors. Standard steel type flexible conduit is unacceptable.

- b. ANSI/NEMA FB1 steel connectors. Connectors must be PVC coated where installed in corrosive environments or where PVC conduit or PVC coated GRS conduit is specified.
 - c. Flexible conduit installed in hazardous classified areas shall be explosion-proof or be rated for use in the specified area classification.
- B. Non-Metallic PVC Conduit:
- 1. Rigid non-metallic conduit Polyvinyl Chloride (PVC) type II PVC shall be schedule 40, suitable for use with 90 degree rated wire. Conduit shall bear UL labels for above and below ground use.
 - 2. All PVC conduit 1-1/4 inch and larger with bends greater than 45° shall utilize factory bends.
 - 3. Where the enclosure or raceway is subject to physical damage, conductors shall be installed in rigid metal conduit, intermediate metal conduit, Schedule 80 rigid nonmetallic conduit or equivalent.
 - 4. Meet UL standard #651.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. General:
- 1. Raceways shall be concealed, where possible, unless otherwise indicated on the Drawings. When exposed, confirm the exact routing with the Engineer prior to roughing in.
 - 2. Sizing: Minimum conduit sizes are indicated on the Drawings. The Contractor may choose to install larger conduit for ease of installation or wiring pulling at no additional cost to the Owner. If conduit or raceway size is not indicated on the Drawings, raceways shall be sized per NEC. Unless otherwise indicated, minimum conduit size shall be 3/4 - inches.
 - 3. Unless otherwise indicated, all exposed conduits shall be galvanized steel rigid metal conduit (RMC) or intermediate metal conduit (IMC). All direct buried or concrete encased conduits to be Schedule 40 PVC.
- B. Conduit:
- 1. Conduit shall: Have openings temporarily plugged, using “pennies” or equal, to exclude plaster or other foreign materials; be reamed after cutting; have joints cut square, and butt solidly into fittings; have the ends terminated in a proper bushed fitting, be rigidly supported so as to prevent undue stress or strain on the couplings and connectors; be swabbed before conductors are pulled in.
 - 2. Concealed conduits shall be run in a direct line with long sweep bends and offsets. Horizontal runs shall be run with a slight incline, to prevent low spots or pockets (for drainage).

3. Conduits shall be continuous from outlet to outlet, from outlets to cabinets, pull or junction boxes and shall be secured to boxes with lock nuts and bushings in such a manner that each system shall be electrically continuous throughout. “Erickson” couplings shall be used where required. No running threads shall be cut.
4. Install conduit systems completely before conductors are pulled. Conduits shall be securely supported at proper intervals to structures with steel clamps, or conduit hangers or by special supporting assemblies when indicated on the Drawings.
5. Conduit terminations shall contain insulated bushings. Provide grounding type bushings where steel conduit is stubbed into nonmetallic enclosures, stubbed up in the base of freestanding enclosures or where locknuts cannot assure proper ground continuity between metallic enclosures and the steel conduit. Provide service entrance and transformer connection conduits with grounding type bushings.
6. Exposed conduits shall be installed parallel to walls, floor and ceilings or at right angles to the building lines. Exposed bends shall be used only where approved. Covers shall be secured to bodies with machine screws.
7. Electrical metallic tubing (EMT) or “Thin-wall” may not be used except where specifically indicated on the Drawings or as directed by the Engineer.
8. Hickey bends shall not be used for 1-inch and larger conduits. Either manufactured elbows or bends fabricated in a bending machine shall be used. The radius of the inner edge of bends shall be six times the internal diameter of the conduit for conduit sizes up to 2 ½-inches and 12 times internal diameter for 3-inches conduits and larger. A run of conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than 360° of total bends.
9. Conduit shall not be run above or below water piping, and must be individually supported.
10. In wet locations, and in locations where walls are frequently washed, the entire conduit system, including boxes and fittings used, shall be installed and equipped to prevent water from entering conduit. Conduit shall be so mounted so that there is at least ¼-inch air space between conduit and wall or similar supporting surface.
11. Schedule 40 PVC conduit may be used for buried conduit installations as permitted by the NEC and local codes except where galvanized rigid steel is specified. Couplings, transition fittings, adhesives, primer and installation procedures recommended by the conduit manufacturer and all applicable codes must be strictly followed.
12. Install liquid-tight flexible metal conduit at motors, transformers and equipment which are subject to vibration or require movement for maintenance purposes. Provide necessary reducer where equipment

furnished cannot accept 3/4-inch size flexible conduit. Limit flexible conduit length to 3-foot maximum.

- C. Sleeves, Inserts, etc.: Lay out and install work in advance of the laying or pouring of floors and erection of walls. Furnish and install sleeves that may be required for openings through floors, wall, etc. Where plans call for conduit to be run exposed, furnish and install inserts and clamps for the supporting of conduit. If this Contractor does not properly install sleeves and inserts required, he will be required to do the necessary cutting and patching later, at his own expense, to the satisfaction of the Engineer.
- D. Installation of Underground Conduits:
1. Install underground conduit as indicated on the Drawings. Backfill material around the conduits must be clean-fill (dirt with rocks no larger than 1/2-inch).
 2. Conduit bends shall have long sweep radius curves instead of standard elbows where indicated on the Drawings. All PVC conduit bends greater than 45° shall be factory-made for conduits larger than 1-inch.
 3. All underground PVC conduit shall be buried a minimum of 24-inches below finished grade, except when located below a concrete slab or freestanding electrical equipment. Conduit shall be installed deeper than 24-inches wherever required to avoid existing piping, tunnels, or other obstructions.
 4. Underground conduits in ductbanks shall be separated and supported with pre-manufactured plastic chairs, unless submitted and approved otherwise, installed at 5-foot intervals in the trench.
 5. ***After duct is in place, notify the Engineer prior to backfill for inspection.*** Failure to do so will result in removal of all backfill material to expose the conduits for inspection.
 6. During backfill, provide plastic warning tape at 12-inches below finished grade over underground electrical installations which reads, "Caution - Buried Electrical Line Below".
 7. Any portion of the conduit with less than 24-inches of cover shall be PVC coated rigid metal conduit or galvanized rigid metal conduit wrapped with 20-mil rubber tape half-lapped to a thickness of 40-mils. PVC conduits are permitted to be stubbed up directly into freestanding electrical enclosures.
 8. Where terminating PVC conduit in a freestanding enclosure, underground junction box, manhole/handhole or other similar locations, provide each termination with a bell end.
 9. Rigid metal conduit terminations shall contain insulated bushings. Provide grounding type bushings where steel conduit is stubbed into nonmetallic enclosures, stubbed up in the base of freestanding enclosures or where locknuts cannot assure proper ground continuity between metallic enclosures and the steel conduit. Install grounding type bushings on all service entrance and utility transformer connection conduits.

10. Spare conduits shall be capped with an approved plug.
11. Before pulling cables into underground conduits, pull a mandrel ¼-inch smaller than the conduit inside diameter and pulled through each conduit, and if any concrete or obstructions are found, the Contractor shall remove them and clear the conduits. Underground conduits shall be swabbed before cables are pulled in.
12. After duct runs are completed and set, backfill the trenches and tamp thoroughly to 90 percent compaction.

3.02 CONDUIT MARKERS

- A. All conduits with conduit designations indicated on the Drawings shall be identified at each termination. See Section 16195 - Electrical Identification for conduit tag requirements.

****END OF SECTION****

SECTION 16120
WIRES AND CABLES
(600V OR LESS)

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Cables and wires rated 600 volts or less, as specified, including wiring of all devices.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data on all power, signal and communication cables demonstrating compliance with this Specification.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards:
1. NFPA 70 (NEC)
 2. UL listing for materials.
 3. ICEA S-66-524
 4. NEMA WC-7
 5. ASTM B-3 or B-8

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Cable:
1. General Cable
 2. Okonite
 3. Southwire
 4. Encore
- B. Connectors:
1. Ideal
 2. Burndy Corp.
 3. Thomas and Betts Co.
 4. O.Z. Gedney
 5. Minnesota Mining & Manufacturing (3M)

2.02 MATERIALS

- A. Conductors for wire and cable shall be stranded copper with 98 percent conductivity and shall be tinned or untinned in accordance with established standards for the type of insulation around the conductors. Solid conductors are not acceptable.

- B. Wire and cable shall be stamped approximately every two feet to indicate voltage, type, temperature rating, and other significant data or warnings.
- C. Conductors for general purpose wiring shall meet the following requirements:
 - 1. Power: Type XHHW-2. Minimum conductor size for power shall be No.12 AWG.
 - 2. Control: Type XHHW-2 for conductors run in conduit, minimum size No.14 AWG. Type MTW for conductors contained in control panels, minimum size No.14 AWG or No.16 AWG when protected by an overcurrent device of 10A or less.
- D. Wire Pulling Lubricant: Lubricant shall be UL listed and be of a consistency that will not leave an obstruction or tackiness that prevents pulling out wires in the future. No soap flakes or vegetable soaps will be permitted. Lubricant in shall be Ideal Wire Lube or equal.
- E. Cable Ties: Wiring in panels, cabinets, etc. shall be neat and tied with “Ty-Rap” T&B “TY-5418” series, or Panduit Co. “Cable Wrap”. Cable ties used in outdoor locations shall be UV stabilized.
- F. Terminations:
 - 1. 3-M Scotchlok lugs and connectors - copper.
 - 2. O-Z solderless connectors, grounding devices, power connectors, armored cable fittings, and cable terminations.
 - 3. Burndy - copper - all types as appropriate for cable size and configuration.
- G. Connector material shall be compatible with conductor material to prevent corroding, differences in coefficients of expansion or electrolysis.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Install wires and cables in NEC approved raceways (Section 16110). All wire and cable must be installed in a raceway, unless otherwise indicated on the Drawings.
- B. Branch circuit and feeder conductors shall have insulation with the following color. Phase tape is unacceptable.
 - 1. Grounding conductor-Green.
 - 2. Neutral - White.
 - 3. 120/240V Phase A - Black.
 - 4. 120/240V Phase B - Red.
 - 5. 277/480V Phase A - Brown.
 - 6. 277/480V Phase B - Orange.
 - 7. 277/480V Phase C - Yellow.
- C. 6-inch minimum loops shall be provided at each outlet, device or luminaire. Unused wires in outlet boxes, shall be rolled up, connected together and taped or

capped with wire nuts. Mark bundled, unused spare wires as “SPARE FROM [origination]”.

- D. Branch circuit sizing: Where wire size is not indicated on the Drawings, NEC and local codes shall govern. However, minimum branch circuit conductor size shall be No. 12 AWG.
- E. Pulling Cables: Wires and cables shall be carefully handled during installation. Lubricant used for pulling in wires and cables shall be used. Use a dynamometer when pulling conductors by mechanical means.
- F. Bending radius: Do not exceed the manufacturer’s maximum bending radius.

3.02 SPLICES AND TERMINATIONS

- A. Splices:
 - 1. Splices in conductors shall not be used unless otherwise indicated on the Drawings or approved by the Engineer.
 - 2. Where splices are allowed or necessary, they shall be mechanically strong and well made so that the electrical resistance of a joint shall not exceed that of 2-feet of the conductor.
 - 3. Splices shall be made only in junction boxes and never in conduit.
 - 4. Above Grade Splices:
 - a. Utilize wing nut solderless connectors for splicing No. 8 AWG and smaller conductors. Follow manufacturer’s recommendations for sizing, stripping, twisting, etc.
 - b. Utilize insulated butt connectors crimped end-to-end for splicing No. 6 AWG and larger conductors. Follow manufacturer’s recommendations for sizing, stripping and crimping.
 - 5. Below Grade Splices:
 - a. Utilize waterproof splice kits or wing nut solderless connectors with cast-resin waterproofing for splicing No. 8 AWG and smaller conductors. Follow manufacturer’s recommendations for sizing, stripping, twisting, etc.
 - b. Utilize insulated butt connectors crimped end-to-end with cast-resin waterproofing for splicing No. 6 AWG and larger conductors. Follow manufacturer’s recommendations for sizing, stripping and crimping.
 - c. Utilize insulated butt connectors crimped end-to-end for all below grade splices or No. 6 AWG and larger conductor splices above grade. Follow manufacturer’s recommendations for sizing, stripping and crimping.
- B. Motor terminations: Ring type, crimped connectors shall be installed on all conductors and bolted together back-to-back. For terminations with No.6 and smaller wire, use 10-24 bolts. Use bolts that match the connector bolthole size for all other motor terminations. Apply one layer of cambric tape followed by three layers of rubber tape and finally, top with one layer of black vinyl tape.

- C. Non-motor terminations: Use ring or fork type, crimped connectors for all screw-on terminations. Wrapping wire around a binding post is unacceptable.
- D. Where special tools are required to properly install the particular connector the special tools must be used.

3.03 WIRE MARKERS

- A. All conductors shall be labeled at each termination and splice. See Section 16195 - Electrical Identification for wire marker requirements.

****END OF SECTION****

SECTION 16130

BOXES

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Outlet boxes, pull and junction boxes and underground junction boxes.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data for standard outlet boxes up to six gang, including floor type demonstrating compliance with specification requirements and Drawings.
- B. Shop Drawings: Submit drawings for special pull, outlet, and junction boxes demonstrating compliance with NEC and specification requirements. Drawings shall indicate box dimensions and locations in building.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards:
 - 1. NEMA 250
 - 2. NFPA 70
 - 3. UL listing for materials.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Appleton Electric
- B. Crouse-Hinds
- C. Killark
- D. Raco
- E. Hoffman Engineering Co.
- F. O.Z. Gedney Co.
- G. Steel City
- H. Hubbell
- I. Rittal

2.02 MATERIALS

- A. Outlet boxes for concealed conduits and flush-mounted wiring devices shall meet the following requirements:

1. Stamped, one piece, galvanized steel.
 2. Proper size and shape for conduits entering them.
 3. UL listed for their application.
 4. ANSI/NEMA OS-1 for galvanized steel; ANSI/NEMA OS-2 for non-metallic.
- B. Outlet boxes for exposed conduit systems and exterior locations shall be of the threaded-hub, cast-metal, conduit type fitting suitable for the wiring devices to be installed. Covers (blank, switch, receptacle, etc.) shall be the type specifically designed to fit the specified boxes.
- C. Above grade electrical junction and pull boxes shall be sheet metal with an ANSI 61 gray color with size and type as indicated on the Drawings. NEMA rating shall be as indicated on the Drawings. Where a NEMA rating is not indicated, outdoor boxes shall be NEMA 3R and indoor boxes shall be NEMA 12. Box sizes shall be as indicated on the Drawings. Where sizes are not indicated or larger size is required to meet code, the box size shall be increased as required by the National Electrical Code.
- D. Wireways:
1. Wireways shall be sized as indicated on the Drawings or as required by the National Electrical Code. Where sizes are not indicated or larger size is required to meet code, the wireway shall be sized such that the cross-sectional area of the wireway at any one point does not exceed 40% per the National Electrical Code.
 2. Cover: Hinged with removable latches where feasible.
 3. UL listed for steel enclosed wireway or auxiliary gutter.
 4. Furnished complete with covers, elbows, tees, junction boxes, end covers, connectors and hangers.
 5. Unless otherwise indicated, wireways shall be NEMA 3R.
 6. Wireways in outdoor locations shall be fully gasketed.
- E. Underground junction boxes:
1. Construction: Electric underground junction boxes shall be precast concrete and size as indicated on the Drawings. Underground junction boxes shall have precast concrete extensions.
 2. Covers: Covers shall be rectangular, reinforced concrete and have the text "ELECTRIC" cast into the cover.
 3. Approved Manufacturer: Christy, or equal.
- F. Fittings, hangers, fastenings, etc., shall be of material that will prevent chemical reaction between itself and conduit or device it is fastening or supporting.

PART 3 -- EXECUTION

3.01 BOX LOCATIONS

- A. Location of Boxes: In order that boxes may be placed in proper locations, the Contractor shall familiarize himself with the details of these spaces and carefully lay out boxes so that the equipment or piping of other trades passing under, over, across or in close proximity to same, will not cause these boxes to be inaccessible for use or maintenance. Contractor shall consult with other Contractors and trades on the project and obtain details of the project to locate outlet boxes properly.
- B. Contractor shall be responsible for the exact and proper location of the various portions of his work. Consult the Drawing and details.
- C. Mounting Heights: The exact mounting height of each switch, receptacle, light fixture outlet, etc., shall be confirmed on the premises in conference with the Engineer. Unless otherwise indicated, receptacles to be mounted at 18-inches and light switches to be mounted at 42-inches above finished floor/grade.

3.02 INSTALLATION

- A. No thru-boxes shall be permitted.
- B. Boxes shall meet the following requirements:
 - 1. Proper size and shape for conduits entering them.
 - 2. Installed so that device and/or cover plates shall be tight and plumb with wall finish.
 - 3. Have unused openings closed with knock-out closures.
 - 4. Securely fastened to building or structure.
- C. Surface-mounted outlet boxes shall meet the following requirements:
 - 1. Outdoor boxes shall be cast steel or cast aluminum with threaded hubs.
 - a. Fastened with not less than two Paine, Phillips, Ackermann-Johnson, or equivalent, screw anchors and round head machine screws on brick and concrete walls or ceilings.
 - b. Under no circumstances will drilling of cast boxes be allowed.
 - c. PVC coated boxes shall be used for installations with PVC coated rigid steel conduit.
 - d. Be provided with a vapor-proof gasket in wet locations or where indicated as "WP" (weatherproof) on the Drawings.
 - e. Install a weatherproof-while-in-use cover on all outdoor receptacles.
 - 2. Bell boxes may be used for indoor applications where rigid steel or IMC conduit is required.
- D. Flush-mounted outlet boxes shall:
 - 1. Be solid ganged boxes for more than two devices.
 - 2. Contain a plaster ring to bring the wiring device attachment points within ¼-inch of the finished wall surface.
 - 3. Be installed so that device covers are tight and plumb with wall finish.

4. Be installed as close as possible to the lock side of door trim for light switches.
- E. Bracket outlets shall be level and centered on columns or above doors when installed in these locations.
- F. Pull boxes and junction boxes shall be:
1. Installed where indicated on the Drawings or where necessary to not exceed 360 degrees of conduit bends.
 2. Entirely accessible.
 3. Securely mounted to building structure independent of the conduits connected to them.

****END OF SECTION****

SECTION 16140
WIRING DEVICES

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Wiring devices such as but not necessarily limited to power receptacles and light switches.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data for each wiring device including device covers demonstrating compliance with these Specifications and UL labeling.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and standards:
1. NEMA
 2. UL listing
 3. NFPA 70

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Hubbell
- B. Leviton
- C. Bryant
- D. Crouse-Hinds
- E. Pass & Seymour

2.02 MATERIALS

- A. Light switches and receptacles shall meet NEMA WD1 and WD6 standards, be UL listed and be Heavy Duty, **Industrial** Specification grade. Commercial specification grade wiring devices are not acceptable.
- B. Amperage rating of each wiring device shall match the circuit's overcurrent device amperage rating to which it is connected.
- C. Wiring devices shall have an ivory finish unless otherwise specified.
- D. Power receptacles shall be the grounded type. Furnish ground fault circuit interrupter (GFCI) type where indicated on the Drawings or as required by the NEC.
- E. All GFCI receptacles shall be listed weather-resistance (WR) type receptacles.
- F. Light switches shall be the quiet type.

- G. Wiring Device Coverplates:
1. Unless otherwise indicated, coverplates installed indoors or in control panels shall be brushed anodized aluminum.
 2. Weatherproof locations: Wiring devices installed outdoors or where identified on Drawings with “WP” shall contain a gasketed coverplate UL approved for wet locations.
 3. Where weatherproof-while-in-use coverplates are indicated on the Drawings or required by NEC, power receptacles shall be provided with a cover that is listed for “extra duty” and maintains UL approval for wet locations when a cord is plugged into the receptacle.

PART 3 -- EXECUTION

3.01 INSTALLATION/APPLICATION

- A. Devices and coverplates shall be plumb and parallel to adjacent surfaces or trim. Flush-mounted devices must be flush with finished wall surfaces and the coverplates must be tight to surfaces over which they are installed.
- B. Receptacles identified as GFCI or when required by the NEC shall have individual GFCI receptacles installed for each outlet. Installing a single GFCI receptacle and standard receptacles connected to the load side of the single GFCI receptacle is unacceptable.

3.02 FIELD QUALITY CONTROL

- A. Contractor shall verify that the openings have been properly patched around devices without damage to devices.
- B. Damaged or painted devices shall be replaced or cleaned as directed by the Engineer.

****END OF SECTION****

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 -- GENERAL

1.01 SECTION INCLUDES

- A. Nameplates and labels
- B. Wire and cable markers
- C. Conduit markers

1.02 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code.
 - 1. NEC 110-22 Identification of Disconnecting Means
 - 2. NEC 200-6 Means of Identifying Grounded Conductors
 - 3. NEC 200-10 Identification of Terminals
 - 4. NEC 210-5 Identification for Branch Circuits
 - 5. NEC 215-8 Means of Identifying Conductor with the Higher Voltage to Ground
 - 6. NEC 230-70, (B) Service Equipment, Marking
 - 7. NEC 310-11 Marking
 - 8. NEC 310-12 Conductor Identification
 - 9. NEC 400-22 Grounded-Conductor Identification
 - 10. NEC 400-23 Equipment Grounding Conductor Identification
 - 11. NEC 408-13 Panelboard circuit identification
- B. UL standard 224- Standard for Extruded Thermoplastic Insulating Tubing.

1.03 SUBMITTALS

- A. Product Data: Provide catalog data for the following:
 - 1. Wire and cable marking system
 - 2. Nameplate materials and fasteners
 - 3. Conduit markers

1.04 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

PART 2 -- PRODUCTS

2.01 NAMEPLATES AND LABELS

- A. Engraved laminated plastic nameplates with black letters on white background shall be installed on the following as a minimum:
 - 1. Electrical distribution equipment enclosures
 - 2. Disconnect switches and motor controllers
 - 3. Control panels and cabinets
 - 4. Each motor controller or control panel door mounted device
 - 5. Major components, control relays and terminal block strips mounted on the backpanel of control panels
- B. Letter Size:
 - 1. Use 3/8-inch letters for identifying electrical distribution equipment enclosures and other large control panels and cabinets. Use 3/16-inch letters for identifying individual control panel components (inside or out) and small control panels/enclosures.

2.02 WIRE MARKERS

- A. Manufacturer: Raychem Corporation Model ShrinkMark or equal.
- B. Description: heat shrinkable radiation cross-linked, thermally stabilized, modified polyolefin sleeves with 3:1 shrink ratio. Markers shall be UL Standard 224 recognized.
- C. Sleeves shall be smear resistant prior to shrinking and achieve mark permanency when shrunk without the need for permatizing equipment. Sleeves should achieve mark permanency when standard ballpoint pens or high-carbon content fabric ribbons are used. The markers shall be flattened and mounted on a carrier suitable for use with commercially available print equipment. Markers shall be printable on both sides. Markers shall be resistant to common industrial fluids including Freon TF, Isopropyl alcohol, and Ethylene Glycol.
- D. Locations: Each conductor at each termination and splice.
- E. Legend:
 - 1. Power and Lighting Circuits: Branch circuit or feeder number indicated on the Drawings.
 - 2. Control Circuits: Control wire number indicated on approved schematics, interconnection diagrams and shop drawings.
 - 3. Wire numbers shall be the same at both ends of the wire.

2.03 CONDUIT MARKERS

- A. Furnish and install conduit markers on ends of each conduit run and in intermediate locations such as manholes and handholes. Conduit markers shall be 19 gauge, 1 1/2-inch diameter round brass with backfilled legend, Style #250-BL as manufactured by Seton Nameplate Corporation or equal. Marker shall identify conduit as indicated on the Drawings. If a conduit is not identified on the Drawings, the Contractor shall consult the Engineer for the proper identification.

PART 3 -- EXECUTION

3.01 NAMEPLATES

- A. Install nameplates parallel to equipment lines.
- B. Secure nameplates to the exterior of electrical equipment using UL-508A approved die and tapped stainless steel screws (APM SEELSKREW or equal).
- C. Secure nameplate to inside surface or backpanels of control panels with a permanent adhesive (Liquid Nails or equal).

3.02 WIRE MARKERS

- A. Wire markers shall be a minimum of 3/8-inches in length and placed as near as possible to the end of the wire. Orient wire marker such that the writing can be read without turning or twisting the wire.
- B. Wire numbers shall be the same at both ends of the wire.

3.03 CONDUIT MARKERS

- A. Attach markers near the end of exposed conduits with stainless steel tie-wire.
- B. Secure conduit markers to the floor using a permanent epoxy where conduits terminate in bell ends flush with finished floor in freestanding equipment.

****END OF SECTION****

SECTION 16250

DIESEL ENGINE GENERATORS

PART 1 -- GENERAL

1.01 DESCRIPTION:

- A. Section includes furnishing and installing a UL Listed, enclosed outdoor diesel engine-driven standby generators complete with all appurtenances, as indicated on the Drawings and specified herein. The standby generator supplier must be the authorized distributor for the manufacturer of the engine.

1.02 REFERENCE:

A. STANDARDS:

1. National Electrical Manufacturers Association (NEMA):
 - a. AB-1, Molded Case Circuit Breakers.
 - b. ICS, General Standards for Industrial Control and Systems.
 - c. MG-1 1978, Motors and Generators.
 - d. SG3, Low Voltage Power Circuit Breakers.
2. Institute of Electrical & Electronic Engineers (IEEE).
3. Underwriters' Laboratories, Inc. (UL-2200).
4. Diesel Engine Manufacturers Association.
5. National Fire Protection Association (NFPA):
 - a. NFPA-110, Standard for Emergency and Standby Power Systems.
6. American National Standards Institute (ANSI):
 - a. 50.5 Rotating Exciters for Synchronous Machines.
 - b. C50.12 Salient Pole Synchronous Generators and Condensers.
7. Environmental Protection Agency (EPA) 70 FR 39870

1.03 SUBMITTALS:

A. Submit the following:

1. Manufacturer's specifications, catalog data, descriptive matter, illustrations, diagrams, etc., including but not limited to engine, generator, voltage regulator, fuel tank, batteries, battery charger, exhaust system, water jacket heater, output circuit breaker and generator control panel showing compliance with this Specification Section.
2. Drawings: Outline drawing of each generator set with overall dimensions. Interconnection wiring diagrams of the generator control systems showing control connections between generator, transfer switch and auxiliary equipment. Power and control wiring conduit entrance locations. Fuel lines and connections. Base anchoring footprint drawing. Control panel layout.

3. A certificate acknowledging that the generator set will properly start and run the loads indicated on the Drawings for 16 continuous hours with the installation configuration within the CMU block walls as indicated on the Drawings.
 4. Engine generator unit prototype test report of identical size, type and construction. Generator test report shall certify the following:
 - a. Maximum output power
 - b. Maximum motor horsepower starting capacity
 - c. Fuel consumption at full load
 - d. Engine/alternator cooling air flow (heat rejection)
 - e. Transient response and steady state governing
 - f. Alternator temperature rise
 - g. Single step load pickup
 - h. Harmonic analysis indicating THD for voltage and current
 - i. Short circuit test indicating maximum current withstand
 - j. Torsional analysis
 - k. Sound level (dB) at 23 feet from unit.
- B. Factory tests on the engine generator set shall be conducted, certified, documented and submitted to the Engineer for review prior to shipment. The test shall be conducted at rated load and 0.8 power factor in accordance with NFPA Factory Test Reports. Tests shall include the following:
1. Steady-state voltage and frequency analysis
 2. Transient response
 3. Maximum power output
 4. Fuel consumption
 5. Safety shutdowns
- C. Documentation that certifies the standby generator will meet the current Environmental Protection Agency (EPA) and any other state or local emission standards for stationary compression ignition internal combustion engines.

1.04 OPERATING AND MAINTENANCE MANUALS

- A. Identify the size, model and features for each item.
- B. Furnish operating instruction manuals outlining step-by-step procedure required for system startup and operation, including manufacturer's name, model number, service manual parts list and brief description of all equipment and basic operating features. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
- C. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or

components not related to equipment furnished must be removed or crossed out. *O&M manuals must be individually tailored to the project and equipment as furnished.*

- D. Furnish maintenance instruction manuals outlining maintenance procedures, including a troubleshooting guide listing possible breakdown and repairs, and a simplified connection wiring diagram for the system.
- E. Copy of warranties issued on the installation, showing dates of expiration.
- F. Refer to Specification Section 16010 for additional requirements.

1.05 QUALITY ASSURANCE

- A. Contractor to ensure that concrete pad, conduit, conductors and branch circuit device ratings are suitable for the equipment supplied. Contractor shall coordinate with the generator set manufacturer for proper conduit stub up locations prior to installation.
- B. Contractor shall review the installation of the generator and all related equipment as indicated on the Drawings with the generator manufacturer's representative prior to submittal or shop drawing preparation. Any concerns with the installation as designed shall be brought to the attention of the Engineer immediately. Failure of the generator to operate properly due to confinements of the installation, whether by design or not, will be corrected by the Contractor at no cost to the Owner.
- C. The generator set manufacturer shall be responsible for and guarantee that the standby generator will operate at full load for 16 hours continuous at the location indicated on the Drawings. Any upgrading of components or modifications to the generator set required for proper operation (larger radiator, remote mounted radiator, fuel cooler, air intakes/ventilation, louvers, etc) shall be done at no cost to the Owner.
- D. The standby generator shall meet the latest Environmental Protection Agency (EPA) emission standards adopted by the authority having jurisdiction in the location where this generator will be installed.
- E. Where required by the EPA, State or other authority having jurisdiction, the Contractor shall be responsible for obtaining an Air Quality Permit for the Owner to operate the standby generator. The permit shall be obtained from the Arizona Department of Environmental Quality and/or any other authority having jurisdiction. The permit shall be filled out in the Owners name. Permit cost will be reimbursed by the Owner.

1.06 WARRANTY AND SERVICE

- A. A manufacturer's warranty shall be furnished on all components, parts, assemblies and performance of the generator against defects in materials and workmanship for a period of 2-years from the date of shipment. Warranty shall include parts, labor and travel expenses.

- B. The equipment manufacturer must have a local service center within a 400-mile radius of the project site with stocked spare parts and staffed with trained, full-time employees who are capable of performing testing, inspecting, repair, and maintenance services.

1.07 MANUFACTURERS

- A. Caterpillar Tractor Co., Peoria, IL
- B. Cummins Power Systems, Minneapolis, MN
- C. Generac Power Systems, Waukesha, WI

PART 2 -- PRODUCTS

2.01 GENERAL

- A. The engine, generator and all associated equipment as specified herein shall provide standby power during periods of normal power failure from utility.
- B. The engine-generator set shall consist of one engine and one generator.
- C. The engine-generator set shall be mounted on a structural steel frame or skid. Vibration isolators suitable to prevent transmission of vibration to the concrete pad shall be provided between the set and the frame.
- D. The engine-generator set shall have a minimum standby power KW rating as indicated on the Drawings at 0.80 power factor. Derate for temperature and elevation as necessary to verify that the minimum generator KW ratings indicated are correct.
- E. The generator shall operate at a speed not to exceed 1,800 rpm, and have an output voltage and phasing to match that of the *Normal* source.
- F. Instantaneous voltage dip for all possible sequences of load application and motor starting for loads described in conditions of service shall not exceed 30 percent of nominal voltage. Instantaneous voltage dip for step starting the loads as indicated below shall not exceed 30 percent of nominal voltage.
- G. Frequency regulation shall be isochronous from no load to rated load.
- H. Voltage regulation from no load to rated load shall have cyclic variations in RMS voltage not to exceed +/- 1.0 percent and a speed variation not to exceed +/- 5.0 percent of rated speed.

2.02 GENERATOR:

- A. Generator shall be rated for standby duty; shall be a 4-pole rotating field, engine-driven, direct-connected, synchronous type with amortisseur windings. Generator frame shall be dripproof with all openings guarded. Bearings shall be a single, prefabricated, sealed ball type.
- B. Generator insulation shall be Class H in accordance with NEMA Standard MG1-1.65 and BS2757. 125°C temperature rise at standby power rating.

- C. The AC generator, voltage regulator and exciter shall be designed and manufactured by the generator set manufacturer.
- D. Voltage regulator shall be an automatic, temperature compensated, solid-state type with a manual adjustment range of plus or minus 5 percent of rated voltage. The voltage regulator shall be equipped with 3-phase RMS sensing, overvoltage and overexcitation protection. Overvoltage and overexcitation protection features shall latch requiring the generator to be shutdown for reset.
- E. Exciter shall be brushless with full-wave silicon diodes mounted on the rotating shaft with a surge suppresser connected parallel with the field winding. Exciters utilizing field discharge resistors is not acceptable. Minimum rating of exciter shall be as indicated in NEMA Std. MG-1-22.16.
- F. Fast acting fuses or other protective devices shall be incorporated where failure of regulator or exciter components could result in damage to the generator field or exciter windings.
- G. Voltage regulator and static exciter shall be mounted in generator control panel or elsewhere so as to protect from and isolate from vibration.
- H. Generator and exciter shall conform to all applicable requirements of NEMA Standards, Publication MG1-1987, for Motors and Generators. Generators and exciters shall also conform to ANSI Standards C50.5, Rotating Exciters for Synchronous Machines and C50.12 Salient Pole Synchronous Generators and Condensers, as applicable.
- I. A permanent magnet generator (PMG) shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by nonlinear SCR controlled loads on the generator. The PMG shall sustain main field excitation power for optimum starting and to sustain short circuit current for selective operation and coordination of system overcurrent devices.
- J. Generator lead terminal box shall be of sufficient size to accept and terminate conductors as indicated on the Drawings. Field terminations to the generator leads shall be furnished with the proper terminal lugs suitable for the conductor size(s) as indicated on the Drawings.

2.03 DIESEL ENGINE

- A. Heavy-duty compression-ignition, cold-starting diesel type arranged for direct connection to an alternating current generator. It shall be a current model of a type in regular production by a manufacturer regularly engaged in building this type of diesel engine.
- B. Engine shall have at least a published intermittent brake horsepower rating at specified generator speed required by generator at rated full load output and shall operate without undue heating, vibration, or wear.
- C. Engine shall be four-cycle and may be naturally aspirated, or scavenged.
- D. Engine shall operate on *low sulfur* No. 2 diesel fuel oil.

- E. An electronic governor consisting of a speed sensor, adjustable electronic control and an actuator to provide automatic isochronous generator set frequency control.
- F. Performance, materials, and workmanship shall be in accordance with Diesel Engine Manufacturers Association standard practices.

2.04 FUEL STORAGE SYSTEM

- A. Provide a double-wall fuel tank with spill containment under the structural steel base. As a minimum the tank shall incorporate threaded pipe connections for fuel level gauge, fuel leak detection, low fuel level sensor, fuel suction line, fuel return line, vent, drain and a 1" spare port. Leak detection and a low fuel level sensor shall be pre-wired to the generator control panel with dry contacts for remote monitoring.
- B. Tank shall have capacity to operate generator at full load for 24-hours minimum.
- C. **Tank design shall be such that gauges, control panel and operating mechanisms (circuit breaker handle, emergency stop button, keyed switch, etc) are not located more than 72-inches above the concrete pad.**

2.05 ENGINE FUEL SYSTEM

- A. Diesel fuel system shall consist of an engine-driven, positive displacement fuel supply pump, fuel filters, and a secondary contained fuel piping system.
- B. Fuel filters shall be replaceable without breaking any fuel line connection or disturbing fuel pumps or any other part of engine. Oil filters shall be conveniently located ahead of injection or circulating pump so that fuel is thoroughly filtered before it reaches injectors. Screens or filters requiring cleaning or replacement shall not be used in injection or circulating pump, or in injection valve assemblies.
- C. Water separators shall be furnished to separate the water from the diesel fuel. A probe to detect water in the diesel fuel shall be provided to activate the Generator Failure/Malfunction alarm when the presence of water is detected in the fuel.

2.06 ENGINE COOLING SYSTEM

- A. The generator set shall be supplied with a closed-loop, skid-mounted radiator with a belt-driven fan and integral jacket water circulating pump.
- B. Provide radiator of sufficient capacity to operate the engine generator set at full load in 100°F ambient temperature at site elevation for 16 consecutive hours.
- C. Provide water jacket heater(s) to provide positive water circulation, thermostatically controlled to operate between 100 and 120°F. Voltage shall be 120V for 2kW and below or 240V, 1Ø for heaters over 2kW. Heater shall be equipped with a power cut-off relay and shutoff valves at both inlet and outlet sides.

2.07 ENGINE LUBRICATION

- A. Provide full pressure system, supplying oil to all surfaces requiring lubrication. Circulation shall be by positive displacement pump. Full flow-type filters or filters with bypass feature shall be included. Filter elements shall be replaceable without disconnecting oil piping. Provide an oil cooler, if recommended by engine manufacturer, to properly lubricate engine at full rated generator load.

2.08 ENGINE APPURTENANCES

- A. Furnish engine with following appurtenances:
 - 1. Combustion air cleaner of oil bath type or dry replaceable filter type. A tube shall connect crankcase breather with air cleaner to prevent accumulation of objectionable smoke and fumes.
 - 2. Exhaust silencers for residential silencing complete with drains and flexible stainless-steel connection. Design and provide exhaust piping system, including seismic analysis, vibrations isolators, expansion joints.
 - 3. Exhaust piping shall be steel with flexible connections. The exhaust piping shall include a condensation trap(s) with drain valve(s) to prevent water from entering the engine. An exhaust rain cap and all necessary fittings shall be provided on the stack outlet.
- B. The generator set shall be supplied with a molded case, thermal magnetic type main circuit breaker, mounted and wired. Voltage and amperage shall be as indicated on the Drawings. Amperage Interrupting Capacity (AIC) shall match or exceed maximum RMS symmetrical short circuit current available from the generator during a bolted phase-to-ground fault.

2.09 ENGINE ELECTRICAL SYSTEM:

- A. Electrical system shall include batteries, electric starter, voltage and current-regulated charging generator or alternator, and a separate battery charger. Both a manual starting switch and fully automatic starting from a remote pilot device shall be furnished.
- B. Batteries and starter shall be of suitable capacity to start engine through three starting cycles of 10 seconds each. If the generator has not started after three starting cycles, it shall be shutdown automatically until manually reset.
- C. Battery charger shall be automatic, two rate type providing for equalizing charge and continuous taper charging. Output characteristics shall match requirements of battery furnished. Provide charger suitable for operation on 120 volt, single-phase, 60-Hertz current to be rated not less than 10-amp direct current. Furnish battery charger with following features:
 - 1. Direct current voltage regulation: plus or minus 2 percent for variations in line voltage of plus or minus 10 %.
 - 2. Direct current voltmeter and direct current ammeter, each with suitable scales.
 - 3. Automatic surge suppresser.

4. Automatic current limiting to prevent overloading due to engine cranking, shorted output or reversed battery connections.
 5. Alternating current line fusing.
 6. Built-in equalize charge timer.
 7. Integral protection to prevent battery discharge through charger on loss of alternating current line voltage.
 8. Set of normally open dry contacts to close on Low Battery Alarm.
- D. Provide battery rack with battery hold-down clamps to accommodate starting batteries within the generator enclosure.

2.10 CONTROL PANELS

- A. The generator set shall be provided with a microprocessor based control system to provide automatic starting, monitoring and control functions for the generator set. The control panel shall be UL 508A labeled and manufactured by the generator manufacturer specifically for the generator set supplied.
- B. The control panel shall be mounted on the generator with vibration isolators. The maximum height above grade or viewing platform to the center of the highest digital display or meter shall not exceed 66". Where the control panel digital display mounting height exceeds this, it shall be reinstalled by the generator manufacturer **or** the Contractor shall fabricate a steel framed 36" x 36" viewing platform with aluminum grating and stairs at no cost to the Owner.
- C. Control panel doors and all door-mounted devices shall be gasketed and dust-tight. All remote control and monitoring signals shall be terminated on terminal blocks.
- D. The control panel shall be provided with the following controls/meters:
1. RUN/OFF/AUTO selector switch (3-position switch or keypad)
 2. Mushroom head, maintained EMERGENCY STOP pushbutton
 3. ALARM RESET pushbutton
 4. PANEL LAMP pushbutton to illuminate controls and meters
 5. Voltmeter
 6. Ammeter
 7. Frequency meter
 8. Kilowatts (kW)
- E. The following status and alarms shall be displayed on the digital display panel:
1. Engine Oil Pressure (psi)
 2. Low Oil Pressure Alarm
 3. Engine Coolant Temperature (°F)
 4. High & Low Coolant Temperature Alarms
 5. Overcrank Alarm

6. Overspeed Alarm
 7. High & Low DC Voltage Alarms
 8. Low Fuel Alarm
 9. High & Low Output Voltage Alarms
 10. Under frequency Alarm
 11. Overload/Overcurrent Alarm
 12. Ground Fault Alarm
 13. Engine Speed (RPM)
 14. Running Time (hours)
 15. Battery Voltage (DC Volts)
- F. The control system shall include a ground fault monitoring relay with an adjustable time delay for alarm. The ground fault relay shall be used for alarm monitoring only, not to trip the main circuit breaker, unless otherwise indicated.
- G. Form "C" dry contacts shall be provided for remote monitoring of alarms as indicated on the Drawings. The contacts shall be rated 2A at 30 VDC, minimum.

2.11 OUTDOOR WEATHERPROOF ENCLOSURE

- A. Provide a weatherproof enclosure for the engine, and associated components.
1. Enclosure shall include an updraft duct with bird screen on the radiator end to direct the generator's discharge air upward.
 2. Enclosure to have fully gasketed doors for access to all portions of the generator that requires any maintenance. All doors to have rain molding above door opening, stainless steel hinges and a two point latch to allow the doors to be completely removed. Handles to be the key locking type.
 3. As a minimum, the enclosure roof, walls and doors shall contain 1/2" deep support ribs with 16 gauge minimum exterior steel with interior sound attenuation insulation. Insulation shall consist of minimum #6 density wool held in place with a perforated liner.
 4. All seams shall be caulked with a sealer prior to painting. Paint exterior surfaces of equipment with two coats of acceptable oil and heat-resistant paint, applied after surfaces have been thoroughly cleaned and prepared with suitable priming coat. **Exterior color shall be desert tan unless otherwise directed by the Owner.**
 5. Provide fixed louvers with a screened cover over air openings sized as required for proper airflow.
 6. The enclosure shall have a steel base channel constructed to drop *over* the generator set with anchor boltholes for fastening to the generator frame or concrete slab.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Install unit complete and make operational.
- B. Install muffler(s) horizontally above the unit.
- C. Provide ½-inch (12mm) copper drain with draincock on bottom of muffler to nearest drain for periodic draining of muffler.
- D. Provide vibration isolation of exhaust equipment to prevent transfer of vibration into building components.
- E. Provide vibration isolators suitable to prevent transmission of vibration from the generator frame to the concrete pad or building floor. Securely anchor the generator frame to the concrete pad/floor with galvanized anchor bolts shall be furnished by engine-generator set manufacturer. Obtain from supplier of engine-generator set a drawing giving location and size of foundation bolts for unit proposed, in sufficient time to be available when needed to place foundation.
- F. Electrical equipment and materials shall be listed by UL wherever standards have been established by that agency.

3.02 WIRING AND CONNECTIONS

- A. Provide conduit, wiring, and connections required and recommended by generator supplier. All conduit and fuel line stub-ups shall be contained within the generator set frame.
- B. Connect generator frame to the electrical service grounding system as indicated on the Drawings. The generator neutral conductor shall be run to the service entrance equipment isolated from ground via the automatic transfer switch and bonded to the service equipment neutral bus.
- C. For 3Ø, 3W standby power supply: Install a main bonding jumper (MBJ) between the generator neutral and the generator ground bus/frame. Size as indicated on the Drawings for the service entrance section.
- D. For 1Ø, 3W standby power supply: Do not install a main bonding jumper (MBJ) between the generator neutral and ground bus/frame. If the generator is furnished with a MBJ, the Contractor shall remove it before conducting any standby power system testing. The neutral conductor shall be run to the service entrance equipment isolated from ground via separate terminals in the automatic transfer switch and bonded to the service equipment neutral bus.

3.03 TESTING

- A. On-site Tests:
 - 1. Unless certified in the factory test report, the generator manufacturer must pressure test the fuel line and the secondary containment piping in accordance with the Uniform Fire Code and any applicable Local, State, or Federal requirements.
 - 2. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown and return to normal. Record the

time to achieve standby power after loss of the *Normal* power source. Record the time to retransfer back to the *Normal* power source.

3. Verify fuel tank is full, then provide a full load test for the aeration system standby generator utilizing a portable resistive load bank, for eight (8) hours. Full load shall be the kVA as indicated on the generator set nameplate. Supply all fuel and portable test bank required for testing.
 - a. Record in 20 minute intervals during the on-site test:
 - 1) Time of Day
 - 2) Kilowatts
 - 3) Amps
 - 4) Voltage
 - 5) Coolant temperature
 - 6) Air temperature
 - 7) Frequency
 - 8) Oil pressure
 - 9) Battery charging rate
 - b. Test all alarm and shutdown circuits by simulating fault or failure conditions.
 - c. Refill fuel tank after full load test is complete and record the volume of fuel required to refill the tank.

3.04 TRAINING

- A. Operator training shall be provided by the generator manufacturer's factory-trained representative.
- B. The training shall be conducted at the project site.
- C. The training session shall include up to four Owner's representatives.
- D. The training session shall be a minimum of four (4) hours, conducted on a normal workday as decided upon by the Owner.
- E. The training session shall include the proper maintenance and operation of the standby generator and automatic transfer switch.

****END OF SECTION****

SECTION 16260

AUTOMATIC TRANSFER SWITCH

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Automatic transfer switches, 600V and below with accessories as indicated herein.

1.02 REFERENCE:

- A. STANDARDS:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. ICS, General Standards for Industrial Control and Systems.
 - 2. Institute of Electrical & Electronic Engineers (IEEE).
 - 3. Underwriters Laboratory (UL) 1008
 - 4. National Fire Protection Association (NFPA):
 - a. NFPA-110, Standard for Emergency and Standby Power Systems.

1.03 SUBMITTALS:

- A. Submit the following:
 - 1. Product Data: Provide catalog data on all components in accordance with this specification.
 - 2. Drawings: Interconnection wiring diagrams for the generator control systems indicating control connections between the generator and automatic transfer switch. Power and control wiring conduit entrance locations.

1.04 OPERATING AND MAINTENANCE MANUALS

- A. Identify the size, model and features for each item.
- B. Furnish operating instruction manuals outlining step-by-step procedure required for system startup and operation, including manufacturer's name, model number, service manual parts list and brief description of all equipment and basic operating features. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
- C. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or components not related to equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
- D. Furnish maintenance instruction manuals outlining maintenance procedures, including a troubleshooting guide listing possible breakdown and repairs, and a simplified connection wiring diagram for the system.

- E. Copy of warranties issued on the installation, showing dates of expiration. Warranty period shall begin at date of substantial completion.
- F. Refer to Specification Section 16010 for additional requirements.

1.05 QUALITY ASSURANCE

- A. Contractor to ensure that conduit size and wire quantity, size, and type are suitable for the equipment supplied.
- B. Comply with the following Codes and Standards:
 - 1. UL listing and labeling for materials.
 - 2. UL 1008
 - 3. NFPA-70.

1.06 WARRANTY AND SERVICE

- A. A manufacturer's warranty shall be furnished on all components, parts, assemblies and performance of the transfer switch for a period of 2-years from the date of substantial completion. Warranty shall include parts, labor and travel expenses.
- B. The equipment manufacturer must have a local service center within a 400-mile radius of the project site with stocked spare parts and staffed with trained, full-time employees who are capable of performing testing, inspecting, repair, and maintenance services.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. ASCO
- B. Cummins
- C. Generac
- D. Or equal

2.02 MATERIALS

- A. The transfer switch shall be provided with ratings, number of poles/wires and installed as indicated on the Drawings. The short circuit withstand ampacity shall meet or exceed the indicated AIC rating of the electrical equipment immediately connected to the load side of the transfer switch. The transfer switch shall be capable of switching all classes of loads while under full load.
- B. The transfer switch shall be provided with a NEMA rated enclosure as indicated on the Drawings.
- C. Load transfer shall be delayed transition, three position (center off) electrically and mechanically interlocked contactors. Interlocked circuit breakers are not acceptable.

- D. Main switch contacts shall be silver or have silver alloy surfaces, arcing tips and arc extinguishing devices. Transfer switch shall be capable of closing on an inrush current 20 times its full load rating without contact damage and capable of withstanding a system short circuit fault until the overcurrent device trips. Total transfer time in either direction shall not exceed one-half second. Interlock *Normal* and *Emergency* contactors both mechanically and electrically so that both cannot be closed at any one time.
- E. Switching contactors and cable connections shall have a transparent protective cover to protect operating personnel from accidental contact and allow visual determination of the transfer switch position.
- F. The transfer switch shall be provided with a door mounted, 3-position selector switch or keypad with password for TEST, NORMAL and RETRANSFER manual transfer control which will activate the transfer switch with the same contact-to-contact speed as automatic operation.
- G. There shall be a separate adjustable time delay (0-2 min.) for transferring power from the *Normal* to *Emergency* and retransferring back.
- H. As a minimum, the transfer switch shall be provided with the following:
1. Open transition type controls necessary for a delay in transfer.
 2. Temperature compensated, solid-state voltage sensors shall simultaneously monitor all phases of both normal and standby power sources. Transfer from *Normal* to *Emergency* source shall occur when the *Normal* source voltage and frequency drops below an adjustable 85-95 percent nominal for a period of time as set by the time delay to transfer (0-2 minutes). Retransfer back to *Normal* shall occur when the *Normal* source has been restored to nominal an adjustable 85-95 percent for a period of time as set by the time delay to retransfer (0-30 minutes).
 3. An adjustable time delay (0-5 seconds) with a suitable contact for starting an engine generator upon loss of *Normal* power.
 4. Transfer of power to the standby source shall occur within 10 seconds of loss of *Normal* power.
 5. 250V, 10A, Form "C" auxiliary and control contacts as follows:
 - a. Two contacts that are closed when the transfer switch is in the *Normal* position.
 - b. Two contacts that are closed when the transfer switch is in the *Emergency* position.
 6. After retransfer of power from a standby generator source, the generator shall remain running for an adjustable time period as set by a timing relay (0-10 minutes).
 7. Separate pilot lights to indicate the presence of each source and transfer switch position.

8. Separate status indicators to indicate the presence of each power source, signal to start engine generator, transfer/retransfer timing, transfer/retransfer complete and stop generator timing.
9. Full rated lugs for *Normal*, *Emergency* and *Load* conductors as indicated on the Drawings.
10. Terminal blocks for all control and monitoring field-wiring connections as indicated on the Drawings and as specified herein.
11. A 7-day, 24-hour adjustable exerciser clock or, if indicated on the Drawings, a remote start/stop input shall be capable of exercising the generator set under *No Load* condition.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Install where indicated on plans. Mount unit such that it is level and plumb.
- B. Prior to installation, coordinate with other trades to verify conduits have adequate space to leave and enter the switch enclosure and for required code clearance. A minimum working clearance as defined by the NEC 110-26 shall be provided.
- C. Install in accordance with NFPA 70 and all applicable local codes and regulations.

3.02 TESTING

- A. Factory Tests:
 1. Provide factory production tests in accordance with NEMA standards and NFPA standard 110. Check and set all instruments and safety devices.
- B. On-site Tests:
 1. Simulate utility power failure to verify proper operation of the automatic transfer switch, automatic starting and stopping of the standby generator and retransfer back to utility when utility power is resumed. Record the time to achieve standby power after loss of the *Normal* power source. Record the time to retransfer back to the *Normal* power source.
 2. Verify all status and alarm signals being monitored remotely.
 3. Coordinate with the Owner for programming the exerciser clock settings.

3.03 TRAINING

- A. The Contractor shall provide training by a manufacturer's factory-trained representative.
- B. The training shall be conducted at the project site.
- C. The training session shall include up to four Owner's representatives.
- D. The training session shall be a minimum of two (2) hours, conducted on a normal workday as decided upon by the Owner.

- E. The training session shall include the proper maintenance and operation of the automatic transfer switch.

****END OF SECTION****

SECTION 16400
FREESTANDING
SERVICE ENTRANCE SECTION

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Freestanding electrical service entrance section and service disconnect.

1.02 SUBMITTALS

- A. Product Data: Submit catalog cuts and manufacturer's descriptive literature for approval for:
1. Service Entrance Sections
 2. Service Disconnect
- B. Shop Drawings:
1. Submit drawings showing dimensions and dimensional clearances within the structure.
 2. Include metering, ground fault protection, if required; breaker/fusing, dimensioned bus locations, digital metering and instrument transformers.
 3. Submit single line diagram and any associated schematic and wiring diagrams for equipment in the service and distribution equipment.
 4. All electrical characteristics (voltage, phasing, amperage, bracing, interrupting capacity).
- C. Serving electric utility company coordination:
1. The Contractor shall submit the above listed information to the serving utility company for approval of proposed service entrance equipment. The Contractor shall submit written approval from the serving utility company to the Engineer.

1.03 QUALITY ASSURANCE

- A. Meet requirements of NEC (NFPA 70)
- B. Codes and Standards:
1. NFPA 70-NEC
 2. NEMA
 3. U.L. listed
 4. ICEA
 5. IEEE
 6. ANSI
 7. Local utility company

- C. Service equipment shall bear markings “Suitable for Use as Service Equipment” or be UL listed as “Service Equipment.”
- D. The manufacturer of the service entrance equipment shall be the manufacturer of the circuit protective devices, and other accessories within.
- E. The manufacturer of the service entrance equipment shall be ISO 9000, 9001 or 9002 certified.
- F. The manufacturer of the service entrance equipment shall have produced similar electrical equipment for a minimum period of five (5) years. If requested by the Engineer, a list of installations with successful operation of similar equipment shall be provided demonstrating compliance with this requirement.

1.04 RELATED WORK

- A. Section 16195 – Electrical Identification
- B. Section 16425 – Distribution Switchboards

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Eaton
- B. Schneider
- C. General Electric Co.
- D. Siemens

2.02 GENERAL CONSTRUCTION

- A. The equipment specified herein shall have the following ratings:
 - 1. Voltage: As indicated on the Drawings
 - 2. Phasing: As indicated on the Drawings
 - 3. Alternating Current Frequency: 60 Hz
 - 4. Bus Bracing: As indicated on the Drawings
 - 5. Bus Amperage: As indicated on the Drawings
 - 6. Protective Device Mounting: Fixed
 - 7. Enclosure: Freestanding, NEMA 3R
- B. The service equipment shall consist of the required number of vertical sections bolted together to form a rigid assembly. The internal components and bussing shall be completely enclosed with dead front construction. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.
- C. All sections of the equipment shall be rear aligned. All protective devices shall be group mounted. Devices shall be front removable and load connections front accessible enabling assembly to be mounted against a wall.

- D. All bus bars shall be silver or tin plated copper. Main horizontal bus bars shall be mounted with all phases arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria of 65°C over a 40°C ambient (outside of the enclosure).
- E. Provide a full capacity neutral bus.
- F. An appropriately sized copper ground bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the assembly. Ground conductors shall be attached to the bus by means of mechanical type lugs.
- G. All hardware used on conductors shall be high-tensile strength and zinc plated. All bus joints shall be provided with conical spring type washers.
- H. Small wiring, necessary fuse blocks and terminal blocks within the assembly shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
- I. Mechanical type terminals shall be provided for all line and load terminations suitable for copper cable rated for 75°C.
- J. Assembly shall be furnished with an underground incoming line section as indicated on the Drawings and a separate barriered-off utility metering compartment complete with hinged sealable door(s). Bus work shall include provisions for mounting utility company current transformers and potential taps or transformers as required. Lugs shall be provided in the incoming line section for connection of the serving utility's cables.
- K. Provide stamped steel manufacturer's master nameplate(s) on the exterior door that identifies the assembly's designation, voltage, phasing, amperage, short circuit rating, manufacturer's name, general order number and item number. Secure nameplate(s) to exterior door using stainless steel, self-tapping screws.
- L. All exterior and interior steel surfaces of the assembly shall be properly cleaned and provided with a rust-inhibiting phosphatizing coating. Color and finish shall be ANSI 61, unless noted otherwise.

2.03 CIRCUIT BREAKER TYPE PROTECTIVE DEVICES

- A. Circuit breakers shall be of the molded case type.
- B. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy, and arc extinction shall be accomplished by means of arc chutes.
- C. Circuit breakers shall have a minimum symmetrical interruption capacity as indicated on the Drawings.

- D. Circuit breakers shall be equipped with a microprocessor-based sensing trip unit with the following features as a minimum:
1. Each tripping system shall consist of three current sensors, a trip unit, and a flux transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection function. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached.
 2. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
 3. The microprocessor-based trip unit shall have thermal memory capabilities to prevent the breaker from being reset following an overload condition until after a preset time delay.
 4. When the adjustable instantaneous setting is omitted, the trip unit shall be provided with an instantaneous override. Internal ground fault protection adjustable pick-up ratings shall not exceed 1200 amperes. Provide neutral ground fault current sensor for four-wire loads.
 5. Breakers shall have built-in test points for testing the long time delay, instantaneous, and ground fault functions of the breaker by means of a 120 volt operated test set. Provide one test set capable of testing all breakers 400 A frame and above.
 6. System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments: Long time pick-up and delay; Short time pick-up and delay with selective curve shaping; Instantaneous pick-up; Ground fault pick-up and delay with selective curve shaping.
- E. The Contractor shall be responsible for the setting of the adjustable protective parameters of the circuit breakers to ensure proper system protection and coordination.

2.04 ARC FLASH WARNING LABEL

- A. Furnish each service entrance section with an Arc Flash Warning label to read:

“WARNING
Arc Flash and Shock Hazard
Appropriate (PPE) Required”

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. The Contractor shall provide the services of a qualified and certified factory-trained manufacturer's representative as necessary for assistance in the installation and start-up of the equipment specified herein. The representative shall provide technical direction and assistance in making adjustments and testing of the equipment.
- B. Furnish and install service entrance equipment as indicated on the Drawings, in accordance with the serving utility's requirements, in accordance with the NEC and all applicable local codes and regulations.
- C. Install main bonding jumper and provide grounding of service entrance equipment per the NEC, serving utility and applicable local code requirements.
- D. Before energizing, perform the following tasks:
 - 1. Remove all scraps of wire, dust, dirt and any other foreign material.
 - 2. Inspect the switchgear for proper installation as recommended in the manufacturer's installation instructions furnished with the gear. Inspect all bus bolts and cable connections to insure that they are tight and terminated properly. Inspect all overcurrent devices for damage and look for components that may have loosened during shipment.
 - 3. Meggar testing: Open all overcurrent devices and remove all instrumentation and control fuses. Use a megohmmeter developing 500 volts to test the switchgear. A minimum of 100-megaohms of resistance must be measured from each phase to ground. Any readings less than this will require the manufacturer to inspect the switchgear and replace or make the necessary repairs.

****END OF SECTION****

SECTION 16401
WALL-MOUNTED
SERVICE ENTRANCE SECTION

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Wall-mounted electrical service entrance sections consisting of utility metering and service disconnect.

1.02 SUBMITTALS

- A. Product Data: Submit catalog cuts and manufacturer's descriptive literature for approval for:
 - 1. Service Entrance Section
- B. Shop Drawings:
 - 1. Submit drawings showing dimensions and dimensional clearances within the structure.
 - 2. Include metering per serving utility requirements and main circuit breaker.
 - 3. All electrical characteristics (voltage, phasing, amperage, bracing, interrupting capacity).
- C. Serving electric utility company coordination:
 - 1. The Contractor shall submit the above listed information to the local serving utility for approval of proposed service entrance equipment. The Contractor shall submit written approval from the local utility to the Engineer.

1.03 QUALITY ASSURANCE

- A. Meet requirements of NEC (NFPA 70)
- B. Codes and Standards:
 - 1. NFPA 70-NEC
 - 2. NEMA
 - 3. U.L. listed
 - 4. ICEA
 - 5. IEEE
 - 6. ANSI
 - 7. Local Utility Company
- C. Service equipment shall bear markings "Suitable for Use as Service Equipment" or be UL listed as "Service Equipment."
- D. The manufacturer of the service entrance equipment shall be the manufacturer of the circuit protective device, and other accessories within.

- E. The manufacturer of the service entrance equipment shall be ISO 9000, 9001 or 9002 certified.
- F. The manufacturer of the service entrance equipment shall have produced similar electrical equipment for a minimum period of five (5) years. If requested by the Engineer, a list of installations with successful operation of similar equipment shall be provided demonstrating compliance with this requirement.

1.04 RELATED WORK

- A. Division 16, Electrical

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Sun Valley Electric
- B. Milbank
- C. Eaton
- D. Schneider
- E. Or equal

2.02 GENERAL CONSTRUCTION

- A. The equipment specified herein shall have the following ratings:
 - 1. Voltage: As indicated on the Drawings
 - 2. Phasing: As indicated on the Drawings
 - 3. Alternating Current Frequency: 60 Hz
 - 4. Bus Bracing: As indicated on the Drawings
 - 5. Bus Amperage: As indicated on the Drawings
 - 6. Protective Device Mounting: Fixed
 - 7. Enclosure: NEMA 3R, surface mounted as indicated on the Drawings.
- B. The service equipment shall consist of an assembly furnished with an incoming line section (overhead or underground as indicated on the Drawings) and a separate barriered-off utility metering compartment complete with hinged sealable door(s). Bus work shall include provisions for mounting utility company current transformers and potential taps or transformers as required by utility. Lugs shall be provided in the incoming line section for connection of the feeder conductors.
- C. The internal components and bussing shall be completely enclosed (metal clad) with dead front construction. All edges of front covers or hinged front panels shall be formed.
- D. All bus bars shall be silver or tin plated copper.
- E. Provide a full capacity neutral landing lug or bus if a three phase, four wire or single phase, three wire system is indicated on the Drawings.

- F. Mechanical type terminals shall be provided for all line and load terminations suitable for copper cable rated for 75°C.
- G. All exterior and interior steel surfaces of the assembly shall be properly cleaned and provided with a rust-inhibiting phosphatizing coating. Color and finish shall be ANSI 61, unless noted otherwise.

2.03 CIRCUIT BREAKER TYPE PROTECTIVE DEVICES

- A. Circuit breakers shall be of the molded case type and shall provide overcurrent protection with inverse time and instantaneous tripping characteristics.
- B. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy, and arc extinction shall be accomplished by means of arc chutes.
- C. Circuit breakers shall have a minimum symmetrical interruption capacity as indicated on the Drawings
- D. Circuit breakers shall have thermal magnetic trip units and inverse time-current characteristics.
- E. The Contractor shall be responsible for the setting of the adjustable protective parameters of the circuit breakers to ensure proper system protection and coordination.

2.04 ARC FLASH WARNING LABEL

- A. Furnish each service entrance section with an Arc Flash Warning label to read:

“WARNING
Arc Flash and Shock Hazard
Appropriate (PPE) Required”

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Furnish and install service entrance equipment as indicated on the Drawings, in accordance with the serving utility’s requirements, in accordance with the NEC and all applicable local codes and regulations.
- B. Install main bonding jumper and provide grounding of service entrance equipment per the NEC, serving utility and applicable local code requirements.

END OF SECTION

SECTION 16425

DISTRIBUTION SWITCHBOARDS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Distribution switchboards and related equipment.

1.02 SUBMITTALS

- A. Shop Drawings: Submit drawings showing dimensions, construction and materials. Include specific information for each piece of equipment including, but not limited to, the following items:
1. Distribution Switchboard
 2. Surge Protective Device (SPD)
- B. Product Data: Submit manufacturer's data on switchboards including the following:
1. Voltage characteristics.
 2. Number of phases.
 3. Frequency.
 4. Short-circuit and continuous current ratings.
 5. Main and branch overcurrent device sizes and A.I.C. ratings.
 6. Section dimensions.
 7. Bussing.
 8. Insulation level.
 9. Type of labels and labeling for every device and what it feeds.

1.03 RELATED WORK

- A. Section 16195 – Electrical Identification
- B. Section 16260 – Automatic Transfer Switch
- C. Section 16400 – Freestanding Service Entrance Section
- D. Section 16461 – Transformers (Dry-Type)
- E. Section 16470 – Panelboards
- F. Section 16475 – Overcurrent Protective Devices

1.04 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (refer to Section 16010):
1. NFPA 70 (NEC)
 2. NEMA PB-2
 3. UL 891 and be UL listed.
 4. ICEA

5. IEEE
6. ANSI

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Schneider
- B. General Electric Co.
- C. Eaton
- D. Siemens

2.02 SWITCHBOARDS

- A. Construction:
 1. Switchboard shall be assembled with the service entrance section as a continuous bussed structure including the automatic transfer switch.
 2. Switchboards shall be furnished with group mounted overcurrent protective devices, automatic transfer switch, panelboard and transformer. Refer to other Specifications Sections contained in Division 16 for additional information.
 3. Switchboard shall contain the required number of vertical sections bolted together to form one metal-enclosed switchboard not more than 90-inches high. Sides, top and rear covers shall be code gage steel, bolted to the switchboard structure. The frame structure members shall be die-formed steel bolted together and reinforced at external corners with rugged gussets internal and external to the structure members.
 4. Enclosure shall be NEMA 3R, freestanding for installation outdoors as indicated on the Drawings.
 5. Vertical sections comprising the switchboard shall be rear-aligned.
 6. Furnish with adequate lifting means, and be capable of being rolled or moved into installation position and bolted directly to the floor without the use of floor sills.
 7. Provide stamped steel manufacturer's master nameplate(s) on the exterior door that identifies the assembly's designation, voltage, phasing, amperage, short circuit rating, manufacturer's name, general order number and item number. Secure nameplate(s) to exterior door using stainless steel screws, APM SEELSKREW or equal
- B. Devices:
 1. Provide switchboard with devices as indicated on the Drawings. Each device shall have a quick-make, quick-break externally operated handle that can be locked in "on" or "off" position.
- C. Bus Bars:

1. The automatic transfer switch shall be bussed from the service disconnect and to the distribution switchboard bussing. All bus bars shall be copper, nested in individual extruded channels in a fiberglass base, to provide a barrier between phases. Bus joints shall be bolted with high tensile steel bolts. Bus joints shall be accessible from the rear of the switchboard for maintenance.
2. Bus bars shall be braced to withstand short circuit mechanical forces of not less RMS symmetrical amps as indicated on the Drawings.
3. Current density of the phase and neutral busses shall not exceed 1,000 amperes per square inch cross-section. Continuous current rating of the bus shall be equivalent to the switch size rating of the main device(s).
4. Feeder device line and load connection straps shall be rated to carry the full continuous current rating of the device switch (not trip rating). Load connection straps shall be insulated and extended beyond the main bus.
5. Ground Bus: Furnish not smaller than ¼ in. x 2 in. copper ground bus secured to each vertical section structure, and extended the entire length of the switchboard.
6. Bus Arrangement: A-B-C type bus arrangement (left- to-right, top-to-bottom, front-to-rear) shall be used throughout to assure convenient and safe testing and maintenance.

D. Wiring:

1. Internal Interlocking and Control Wiring: Fuse blocks and terminal blocks are to be furnished as required within the switchboard. Group control wires leaving the switchboard with terminal blocks and numbered terminal strips.
2. Lugs: Cable connectors shall be mechanical type tin- plated and U/L listed for aluminum or copper cables. See Section 16120.

E. Finish:

1. Steel surfaces shall be chemically cleaned and treated, providing a bond between paint and metal surfaces to help prevent the entrance of moisture and formation of rust under the paint film. Switchboard exterior is to be finished with ANSI61 light gray paint.

2.03 SURGE PROTECTIVE DEVICE (SPD)

A. The switchgear shall be furnished with an SPD specifically designed for mounting in the switchboard. The unit shall have the following features and functions:

1. UL 1449, 3rd Edition listed
2. UL 1283 listed
3. Minimum Surge Current Rating shall be as indicated on the Drawings.
4. Modes of protection: L-L, L-G, L-N, N-G
5. The maximum UL listed voltage protective rating (VPR) for each mode of protection shall not exceed the following:

<u>Mode</u>	<u>277/480</u>
Line-Neutral	<u>1200 VAC</u>
Line-Ground	<u>1200 VAC</u>
Neutral-Gnd	<u>1200 VAC</u>
Line-Line	<u>2000 VAC</u>

6. Status pilot lights, Form C relay contact, EMI/RFI filtering (50dB noise attenuation from 10kHz to 100MHz), and surge counter
 7. Minimum 10 year warranty
- B. Acceptable manufacturers:
1. Schneider Surgellogic Series
 2. Eaton PSPD Series
 3. Siemens TPS3 Series
 4. Or equal

2.04 ARC FLASH WARNING LABEL

- A. Furnish distribution switchboard with an Arc Flash Warning labels on each section to read:

“WARNING
Arc Flash and Shock Hazard
Appropriate (PPE) Required”

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Install switchboards in strict accordance with manufacturer’s instructions.
- B. Provide bussed sections for the automatic transfer switch, panelboard and transformer as indicated on the Drawings. These sections shall be assembled by the switchboard manufacturer and conform to other Specifications Sections contained in Division 16. Coordinate with vendors of other equipment for proper size of each section.
- C. Install the panelboard and SPD behind inner doors (panels). These inner doors (panels) shall be hinged and able to be opened without the use of tools.
- D. Before energizing, perform the following tasks:
 1. Remove all scraps of wire, dust, dirt and any other foreign material.
 2. Inspect the switchboard for proper installation as recommended in the manufacturer’s installation instructions furnished with the gear. Inspect all bus bolts and cable connections to insure that they are tight and terminated properly. Inspect all overcurrent devices for damage and look for components that may have loosened during shipment.
 3. Meggar testing: Open all overcurrent devices and remove all instrumentation and control fuses. Use a megohmmeter developing 500

volts to test the switchgear. A minimum of 100-megaohms of resistance must be measured from each phase to ground. Any readings less than this will require the manufacturer to inspect the switchgear and replace or make the necessary repairs.

****END OF SECTION****

SECTION 16440
DISCONNECT SWITCHES

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Separately enclosed fused, non-fused, rotary and circuit breaker type switches for interrupting power to electrical loads.

1.02 SUBMITTALS

- A. Manufacturer's data for disconnect switches.
- B. Shop Drawings shall contain the following data:
 - 1. Name of motor(s) or load(s) being served.
 - 2. Horsepower and current rating.
 - 3. Voltage rating.
 - 4. Number of poles and wires.
 - 5. Fuse (or circuit breaker) size and type, if applicable.
 - 6. Enclosure NEMA rating.
 - 7. Enclosure dimensions.
 - 8. Number and size of wires required between disconnect and load served.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (refer to Section 16010):
 - 1. NFPA 70 (NEC).
 - 2. UL listing.
 - 3. NEMA

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Square D Company
- B. General Electric Company
- C. Siemens
- D. Eaton

2.02 MATERIALS

- A. Disconnect switches shall be:
 - 1. Fused, non-fused or circuit breaker style with voltage, amperage and number of poles/wires as indicated on the Drawings.
 - 2. Heavy-duty rated.
 - 3. Quick-make and quick-break type.

4. Horsepower rated at 250 volts AC or DC, or 600 volt AC whichever is applicable.
5. Capable of interrupting locked rotor current of the motor horsepower rating of the switch (assumed current of six times the rated full load current).
6. Clearly marked to indicate switch position without opening the enclosure door.
7. Dead-front construction with permanently attached arc suppresser.
8. UL listed removable lugs for copper and/or aluminum cable and front accessible.
9. Furnished with NEMA rated enclosures as indicated on the Drawings. If enclosure NEMA rating is not indicated on the Drawings, switches shall be furnished with NEMA rated enclosures as required by location being installed. NEMA 1, 12 and 3R enclosures shall be constructed of sheet steel. NEMA 4X enclosures shall be constructed of stainless steel.
10. Enclosure doors shall be interlocked to prevent them from being opened when in the ON position.
11. Where required, fused disconnect switches shall be provided with Class R fuses and Class R rejecting kits.
12. Disconnect switches installed for motors being served by variable frequency drives or where indicated shall include a dry contact that opens before the switch blades open. When the disconnect switch is switched to the OFF position, this contact can be used to de-energize serving equipment before the phase conductors are opened.
13. Capable of being padlocked in the open position.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Prior to installing disconnect switches, coordinate with other trades to verify conduits have adequate space to leave and enter the switch enclosure and for required code clearance. A minimum working clearance as defined by the NEC 110-26 shall be provided for fused disconnect switches.
- B. Switches shall be securely mounted to a permanent structure and grounded per NFPA 70 (NEC). Where a permanent structure is not available for mounting switch, a supporting structure shall be fabricated and installed as approved by the Engineer. Disconnect switches shall be mounted in a location that is readily accessible and free from obstructions.
- C. Install a lamicaid nameplate on disconnect switch exterior that clearly identifies the load being served as specified elsewhere. Fasten nameplate using stainless steel, self-tapping screws.

****END OF SECTION****

SECTION 16450

GROUNDING

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Grounding and bonding of electrical equipment, raceways and specialized systems, including testing.

1.02 SUBMITTALS

- A. Manufacturer's data for the following:
 1. Connection methods
 2. Ground rods
 3. Ground rod wells

1.03 SYSTEM DESCRIPTION

- A. Ground electrical equipment, conduits, supports, cabinets, and switchgear in accordance with NFPA 70 (NEC) and as shown on the Drawings, the intent being a system ground and an equipment ground.

1.04 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (refer to Section 16010):
 1. IEEE 81-1962--IEEE Recommended Guide for Measuring Ground Resistance and Potential Gradients in the Earth.
 2. NFPA 70 (NEC)
 3. NEMA
 4. UL listing
 5. MIL Handbook 419

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Ground Rods:
 1. Anderson Electric Corp.
 2. Copperweld Corp.
 3. Harger

2.02 MATERIALS

- A. Ground rods shall be copperclad rods $\frac{3}{4}$ -inch in diameter and 10-feet long unless indicated otherwise on the Drawings.
- B. Ground rod wells shall be $8\frac{1}{2}$ -inch diameter constructed of reinforced concrete with a reinforced concrete removable cover stamped "GROUND" as manufactured by Christy or equal.

- C. Connectors, mechanical lugs or wire terminals shall be used only to bond ground wires, junction and panel boxes.
- D. Grounding conductors shall be stranded copper, size as indicated on the Drawings or as required by the NEC. Grounding conductors shall be bare or contain green insulation.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Where mechanical lugs are not welded or fastened with a threaded bolt, surfaces shall be thoroughly cleaned and paint scraped to bare metal before connections are made to insure good metal-to-metal contact.
- B. An equipment grounding conductor must be installed in each conduit with power conductors or, in the case of multi-conductor cable, run inside the cable sheath.
- C. The Contractor shall bond the electrical equipment pad rebar to the service grounding electrode system.
- D. A main system ground, bare copper conductors, size as indicated, shall be run in PVC conduit from the service entrance section to the grounding electrode system as indicated on the Drawings.
- E. Connections to ground rods shall be exothermically welded. Ground rod connections shall be done in a ground rod well for inspection purposes. Ground rod connections may also be done with Burndy "HYTAP" type connectors.
- F. All enclosure doors with 120V mounted devices shall be bonded to the enclosure ground bus.

****END OF SECTION****

SECTION 16461
TRANSFORMERS
(DRY-TYPE)

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Dry-type transformers.

1.02 SUBMITTALS

- A. Shop Drawings: Submit shop drawings indicating outline dimensions, connection and support points, weight, specified ratings and materials, design test, UL listing, and options being provided. Show spatial relationship to adjacent equipment and structures.
- B. Product Data: Submit wiring diagram with protection and control diagram. Clearly differentiate between wiring that is factory installed and portions to be field installed.
- C. Certificates: Furnish the User's Representative with certified high potential test reports performed on each transformer winding at the manufacturer's facilities prior to transformer shipment.

1.03 QUALIFICATIONS

- A. The manufacturer of the transformer shall be the manufacturer of the distribution switchboard.

1.04 REGULATORY REQUIREMENTS

- A. All transformers shall be UL-listed and shall bear the UL label.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Eaton
- B. Schneider
- C. General Electric Co.
- D. Siemens

2.02 GENERAL PURPOSE TRANSFORMERS

- A. KVA and voltage ratings shall be as indicated on the Drawings. Six voltage taps shall be provided; two above and four below nominal voltage in 2.5% increments.
- B. Transformers shall be designed for continuous operation at rated KVA, for 24 hours a day, 365 days a year operations, with normal life expectancy as defined in ANSI C57.96.
- C. Sound Output: Sound outputs of transformers shall not exceed the following levels, based on NEMA standard testing procedures:

<u>KVA Rating</u>	<u>Decibel Sound Output</u>
0 - 9	40
10 - 50	45
51 - 150	50
151 - 300	55
301 - 500	60

- D. Insulation system: Transformers shall be insulated with a 220°C insulation system based upon 115°C rise.
- E. Required performance shall be obtained without exceeding the applicable temperature rise in a 40 degrees C maximum ambient. All insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM Standard Test Method D635.
- F. Transformer core shall be constructed with high-grade, nonaging, silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point. The transformer core volume shall allow efficient transformer operation at 10 percent above the highest tap voltage. The core laminations shall be tightly clamped and compressed. Coils shall be wound of electrical grade aluminum with continuous wound construction.
- G. External cable shall be rated 90°C for encapsulated type and 75°C for ventilated type designs. Connectors shall be provided for cable sizes as indicated on the Drawings. The core of the transformer shall be grounded to the enclosure.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Transformers shall be installed in a blank section of the distribution switchboard by the distribution switchboard manufacturer.

3.02 ADJUSTING

- A. Adjust primary taps so that secondary voltage is within 2 percent of rated voltage.

****END OF SECTION****

SECTION 16470
PANELBOARDS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Lighting and power distribution panelboards as indicated on the Drawings and as specified herein.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data demonstrating compliance with this specification and the Drawings. Information shall include but not be limited to:
 - 1. A panel schedule indicating branch circuit number, size and type of individual circuit breakers, interrupting capacity of the device and number of poles.
 - 2. Short circuit current bracing of the panel.
 - 3. Bus material and mounting type.
 - 4. Demonstrate means of identification of each circuit and of each panel by mark corresponding to the Drawings. Explain any deviations.
 - 5. Clearly indicate all dimensions and that it has been verified that the equipment will fit into place.
 - 6. Indicate ground bus kits.
- B. Test Data: Submit test reports on integrated panel.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (refer to Section 16010):
 - 1. NEMA
 - 2. UL listing
 - 3. NFPA 70 (NEC)
 - 4. W-P-115a Power Distribution, current edition

1.04 RELATED WORK

- A. Section 16010 – Basic Electrical Requirements
- B. Section 16195 – Electrical Identification
- C. Section 16450 - Grounding
- D. Section 16475 – Overcurrent Protective Devices

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Square D Company
- B. Eaton

C. General Electric Co.

2.02 MATERIALS

A. Panelboards shall have the following minimum requirements:

1. UL listed with copper bus bars of 98 percent conductivity and minimum cross sectional area based on UL 67 for heat rise. Bus size and ratings shall be in accordance with UL 67. Minimum bus voltage, amperage and short circuit withstand rating shall be as indicated on the Drawings or as required per NEC.
2. Copper bars shall be provided for terminating equipment grounding conductors and neutral conductors, where applicable.
3. Terminals shall be UL rated for use with copper or aluminum conductors.
4. Panelboards shall include a main circuit breaker or solderless main lugs as indicated on the Drawings. Lugs for main lug only panelboards shall be sized to accommodate the incoming power supply conductors.
5. Fully rated feed-thru lugs shall be provided where indicated.
6. Branch breakers shall be the bolt-on type, unless otherwise indicated.
7. A framed directory pocket shall be provided on the inside door with 1/16-inch thick glass or plastic cover and typed written directory card.
8. A manufacturer's stamped steel nameplate shall be riveted to the exterior indicating voltage, amperage, phases and short circuit bracing.
9. Where indicated, circuit breakers shall have a fixed handle padlock attachment capable of locking the circuit breaker in the off position.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. A minimum working clearance as defined by the NEC 110-26 shall be provided. Whether the panelboard is installed indoors or outdoors, the working space as defined in Table 110-26(a) of the NEC shall apply.
- B. Panelboards shall be installed such that the highest circuit breaker handle is not more than 6'-7" above finished floor.
- C. Provide a means of keeping unauthorized hands out of live panels during construction when panelboard fronts have not been installed.
- D. Complete the panelboard schedule by accurately typing in a brief load description for the appropriate circuit number. Place a copy of the panelboard schedule in the pocket of the panelboard door.
- E. Each branch circuit conductor shall be clearly identified by color as to the phase connection. Wiring in panels shall be neat with rounded corners and tied in bundles with approved ties. See Section 16120.
- F. Where a common neutral is run for more than one branch circuit, the phase conductors shall be connected to separate, consecutive phases in order that the

neutral will carry only the unbalanced current in each phase. Neutral conductors shall be same size as phase conductors unless specifically noted otherwise.

G. Panelboards Mounted in distribution switchboards:

1. Panelboards in distribution switchboards shall be installed by the switchboard manufacturer.

3.02 BALANCING

- A. Panelboard circuiting shall be as indicated on the Drawings whenever possible. Additional loads shall be placed to balance loads between phases as much as possible.

****END OF SECTION****

SECTION 16475

OVERCURRENT PROTECTIVE DEVICES

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Overcurrent Protective Devices such as fuses and circuit breakers.

1.02 SUBMITTALS

- A. Fuses: Submit catalog cuts which indicate the fuse symbol and ampere rating for each disconnect or device.
 - 1. Submit manufacturer's data showing fuse name, symbol, voltage rating, UL class, interrupting capacity or I-squared time (I²t) characteristics and accessories.
 - 2. Fuse trip curves.
- B. Breakers: Submit catalog cuts that indicate type of breaker, size, trip, characteristics, interrupting capacity, and the specified features.

1.03 OPERATING AND MAINTENANCE MANUALS

- 1. Identify the size, model and features for each item.
- 2. Complete instructions regarding the operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
- 3. Refer to Specification Section 16010 for additional requirements.

1.04 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (see Section 16010):
 - 1. NFPA 70 (NEC)
 - 2. UL listing
 - 3. ANSI
 - 4. NEMA

1.05 RELATED WORK

- A. Division 16, Electrical

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Fuses:
 - 1. Bussmann Mfg. Div.
 - 2. Gould-Shawmut
 - 3. Little-Fuse

- B. Circuit Breakers:
 - 1. Schneider
 - 2. Eaton
 - 3. General Electric Co.

2.02 MATERIALS

- A. Fuses:
 - 1. Fuses up to 600 volts shall meet the following:
 - a. Be of the same manufacturer.
 - b. Shall NOT be shipped in fused switches.
 - c. Shall be stored in a safe, moisture free area until needed.
 - d. All dual element fuses shall have separate overload and short circuit elements. The overload element shall include a spring-assisted thermal unit. The thermal unit shall open on a temperature rise above 280 degrees Fahrenheit. Time delay for the overload element shall be at least 10 seconds at 500 percent of rated amperes.
 - e. When indicated on the Drawings or required by the local authority or serving utility, fuses shall be silver-sand UL Class R or Class L current-limiting fuses (low-peak dual element).
 - f. Motor branch circuit fuses rated 1/10 to 600 amperes shall be sized one ampere rating above the selected heater element. Fuse ampere rating shall not exceed 175 percent of motor FLA. Abnormal motor conditions requiring increased ampere ratings shall be referred to the Engineer. Fuses shall be UL Class R current-limiting dual element with time delay.
- B. Circuit Breakers:
 - 1. Low voltage breakers up to 600 volts shall meet the following:
 - a. Be quick-make, quick-break type.
 - b. Have toggle mechanism insuring full contact pressure until time of opening whether manually or automatically operated.
 - c. Thermal magnetic type to have inverse time tripping characteristics with fixed thermal trip action to hold on harmless momentary overload.
 - d. Adjustable trip setting shall be provided for all service entrance section main circuit breakers.
 - e. A short circuit condition shall cause the magnetic trip element to instantly trip without damage or injury.
 - f. Have non-welding, non-corroding contacts.
 - g. Be full-size with mechanism enclosed in molded bake-lite case, sealed to prevent tampering or unauthorized changes in calibration.

- h. Be UL listed and recognized.
- i. Meet NEMA standards.
- j. Be bolt-on type unless otherwise specified.
- k. Have contacts that operate in a multiple plate arc-quenching chamber vented to load side of breaker - UL listed.
- l. Be rated for AIC compatible with ratings of the panel or switchboard bus they are to be used in as indicated on the Drawings. Unless otherwise indicated, series rated devices are not acceptable. All overcurrent devices shall be fully rated.
- m. Be calibrated for operation in a minimum ambient temperature of 50 degree C.
- n. All multi-pole breakers shall have common trip.
- o. For multi-pole breakers shall require the same space as the equivalent number of single pole breakers. Wafer style breakers are unacceptable.
- p. Have operating handle that visually indicates “on”, “off”, or “tripped”.
- q. Be labeled to indicate circuit number(s) and load served.
- r. Be rated for 100% continuous operation where indicated on the Drawings.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Provide overcurrent protection for all wiring and equipment in accordance with NFPA 70, State or local codes, whichever is prevailing.
- B. Should nameplate data disagree with the size or application of an overcurrent protective device indicated on the Drawings, immediately bring it to the attention of the Engineer for a decision.
- C. Place a label inside each fused switch door. Label shall indicate fuse type, ampere rating and interrupting rating. Manufacturers’ labels are acceptable.
- D. Where blank spaces or spaces designated for future overcurrent devices are indicated on the Drawings, they shall be complete with bus links.

3.02 SPARE PARTS

- A. Furnish one spare set of three (3) of each size and type of fuse rated at more than 30 amperes, and 10 percent of each size and type of fuse rated 30 amperes or less, but in no case less than one set of three (3).

****END OF SECTION****

SECTION 16500

LIGHTING

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Luminaires and lamps.

1.02 SUBMITTALS

- A. Submit manufacturer's data for the following:
1. Luminaires with designation as indicated on the Drawings.
 2. Lamps (type, color, wattage, etc.).
- B. Submit manufacturer's data demonstrating compliance with Specifications and the luminaires as indicated on the Drawings.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (see Section 16010):
1. UL listed and labeled.
 2. NEMA
 3. NFPA 70 (NEC)
 4. IES

PART 2 -- PRODUCTS

2.01 MATERIALS

- A. Luminaires shall be:
1. Furnished with proper outlet boxes, hardware, supports, canopy extensions, etc.
 2. Furnished complete with gaskets, cast aluminum weatherproof outlet box, UL Listed for wet locations, have lamp bases coated with an inhibitor to prevent base from corroding to the socket and be solidly grounded.
 3. Furnished complete with lamps with wattage and voltage as indicated on the Drawings.
 4. Furnished with specified finish and color.
- B. Lamps:
1. LED's and their driver shall be designed for minimum operational life of 50,000 hours in -20°C to 40°C ambient air temperature. The lumen output shall not decrease by more than 20% over the operational life. The driver shall decrease output power when the ambient air temperature is outside the -20°C - 40°C range instead of shutting the LED's off. The driver shall be UL listed and include a quick disconnect plug for maintenance. Kelvin temperature shall be 4000K unless otherwise indicated on the Drawings.

PART 3 -- EXECUTION

3.01 INTERFERENCES

- A. Contractor shall carefully examine the complete areas as well as each individual room where luminaires are to be installed, for interference with piping and other trades. Where such interferences occur, provide luminaires with proper type suspension to overcome such interferences.

3.02 INSTALLATION

- A. Luminaires shall be installed parallel with walls and ground for a neat appearance. Where luminaires are indicated to be mounted on a perimeter wall, luminaires shall be installed on a flush mounted box at an elevation such that the top of fixture is flush with the top of wall.
- B. Operate luminaires after installation and connection. Check for proper operation. Replace luminaires that have failed or are not functional.

3.03 OPERATION

- A. Wall mounted luminaires shall be controlled by a light switch located on the enclosure wall as indicated on the Drawings.

****END OF SECTION****

**TUBA CITY WWTP
UPGRADE
ELECTRICAL SPECIFICATIONS
TABLE OF CONTENTS**

16010..... Basic Electrical Requirements

16110..... Raceways

16120..... Wires and Cables (600V or Less)

16130..... Boxes

16140..... Wiring Devices

16195..... Electrical Identification

16261..... Manual Transfer Switch

16400..... Freestanding Service Entrance Section

16425..... Distribution Switchboards

16450..... Grounding

16461..... Transformers (Dry-Type)

16470..... Panelboards

16475..... Overcurrent Protective Devices

16490..... Surge Protective Device (SPD)

16500..... Lighting



SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Electrical general provisions as indicated, specified and required for constructing a complete, ready for use electrical system as described in these Contract Documents.
- B. Labor, materials, apparatus, and appliances essential to the complete functioning of systems described and indicated herein, or which may be reasonably implied as essential, whether mentioned in the Contract Documents or not, shall be furnished and installed by the Contractor. In case of doubt as to the work intended, or in the event of need for explanation thereof, Contractor shall refer to the Engineer for supplemental instructions.
- C. All items not specifically mentioned in these Specifications or noted on the Drawings, or on shop drawings, but which are necessary to make a complete and satisfactory, working electrical/instrumentation installation, shall be deemed to be included herein.
- D. All electrical equipment shall be capable of operating successfully at full-rated load, without failure, at an ambient air temperature of -20°C to 50°C, and specifically rated for an altitude of 4540 feet. Where these criteria cannot be met, ancillary equipment and/or special derating factors as approved by the Engineer shall be utilized.
- E. The Contractor shall perform all necessary saw cutting, core drilling, excavating, removal, shoring, backfilling, etc as required for the proper installation of conduits whether inside or outside of the building(s) and structure(s). The Contractor shall repair and patch where demolition has taken place in a manner to match existing original structure.
- F. Since this facility is in continuous operation, the Contractor shall prepare and submit a flow chart and/or written narrative describing the sequence of construction with duration of anticipated power interruptions.

1.02 SUBMITTALS

- A. Submit documentation for review as described in individual Specification Sections for products requiring submission.
- B. Submit Division 16 in one submittal, or at a maximum, the following may be submitted as separate submittals for this project.
 - 1. Commodities (Sections 16010-16195) and Grounding (Section 16450)
- C. Documentation must be arranged in numerical sequence corresponding with each Specification Section and article of each Section. Soft copies shall be in “pdf”

format with “character recognition” and shall include the following as a minimum:

1. A cover sheet to identify the Contractor’s name, name of the project, date and description, i.e. “Division 16 – Commodities”.
 2. An index corresponding to each specification section with all addendum updates included. Each paragraph or bulleted item shall be check marked to signify compliance with each item and the information is included in the submittal package. If full compliance is not met for any reason, the non-compliance item shall be underlined and reference to a detailed written explanation of the deviation or non-compliance shall be provided in the margin to the right of the specification paragraph or bulleted item for consideration.
 3. Bookmarks within each section for each major component within.
 4. Complete manufacturer name and model number of each item. Listing items “as specified” without both make and model or type designation is not acceptable.
 5. Descriptive Data: complete description, information, and performance data covering materials and equipment that are being proposed. Each component shall be clearly identified on each sheet. Refer to individual specification sections for additional submittal requirements.
- D. If hard copies are provided, they shall be bound in 3-ring binders (2” max) and include all information as described above for soft copies. The binders shall include tabs corresponding to a neatly typewritten index. The binder cover and edge shall clearly identify the Contractor’s name, name of the project, date and submittal number.
- E. Important Notice:
1. **After material or equipment has been submitted and approved, no substitutions will be allowed. Any equipment installed that is different than the approved shop drawings and submittals will be removed and replaced at the Contractor’s expense without exception!**
 2. If Contractor's submittal(s) depart from the Contract Documents, the Contractor shall make specific mention thereof in his letter(s) of transmittal, otherwise review of such submittals by the Engineer shall not constitute review of such departure(s).
 3. The Contractor may be charged for costs incurred by the Engineer for third and subsequent submittal reviews. Cost for Engineer’s review time shall be billed at the Engineer’s standard hourly rates.
- F. For control panels, motor starters and other equipment requiring multiple terminations of components and devices, the Contractor shall submit detailed shop drawings consisting of point-to-point wiring diagrams, bill of materials, interior and exterior elevations with dimensions prepared by the equipment manufacturer or a UL 508A recognized system integrator.

1.03 RECORD DRAWINGS AND OPERATION AND MAINTENANCE MANUALS

- A. Record Drawings: On completion of work, Contractor shall furnish a complete set of Record Drawings and Shop Drawings which properly reflect final locations and sizes of conduit, equipment, controls, etc., as actually installed. Dimensions shall be included on the Contractor's as-built Drawings showing exact location of underground conduits.
- B. Operation and Maintenance (O&M) Manuals: Contractor shall provide O&M manuals for the 480V service entrance section and distribution switchboard furnished under this contract. O&M manuals must be submitted and approved before final inspection of the project so that they may be used during startup. Soft copies shall be in "pdf" format with "character recognition" and shall include the following as a minimum:
 - 1. A cover sheet to identify the Contractor's name, name of the project, date and description, i.e. "Electrical Equipment O&M Manual".
 - 2. Bookmarks within each section for each major component within.
 - 3. Complete manufacturer name and model number of each item.
 - 4. Descriptive data, wiring diagrams, dimensional drawings, etc from the approved submittals/shop drawings.
 - 5. Complete instructions regarding the installation, operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
 - 6. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or components not related to equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
 - 7. Copy of warranties issued on the installation, showing dates of expiration.
- C. Hard copies, if provided, shall be bound in 3-ring binders (2" max) and include all information as described above for soft copies. The binders shall include tabs corresponding to a neatly typewritten index. The binder cover and edge shall clearly identify the Contractor's name, name of the project, date and identified as "Electrical Equipment O&M Manual".

1.04 QUALITY ASSURANCE

- A. The Contractor performing the electrical construction and installation shall be a reputable Contractor licensed in the State of Arizona to do electrical **commercial** construction. As a minimum, an "L-11 Commercial" license is required. If any electrical work over 600V is required, the Contractor must also be licensed to work on High Voltage Electrical and Transmission Lines.
- B. The Contractor must be located within a 400-mile radius of the project and have been in that vicinity for a minimum of five (5) years.

- C. The Contractor must have a minimum of five (5) years experience as a Contractor installing electrical systems for other water and wastewater projects of similar type, size and requirements. If requested, the Contractor must submit documentation and list of references of recent projects similar to this one.
- D. All equipment furnished shall be new and of current design. Like equipment shall be of the same manufacturer.
- E. Unless otherwise indicated, all equipment and components shall be rated for use in the environment installed. Outdoor equipment shall be weatherproof or rated for outdoor use.

1.05 SPACE REQUIREMENTS

- A. Space Requirements: In the preparation of Drawings, a reasonable effort has been made to include equipment manufacturer's recommendations. Since space requirements and equipment arrangement vary according to manufacturer, the responsibility for initial access and proper fit rests with the Contractor. Final arrangement of equipment and service connections shall allow the unit to be serviced, including space to pull motors, change fuses, and operate switches. Minimum working clearances shall be as required by NEC and local codes.

1.06 COORDINATION

- A. Contractor shall coordinate with all other trades to avoid conflicts and interferences. No extra compensation will be allowed for changes made necessary due to interference between work of various trades.
- B. Any discrepancies noted in these contract documents or discrepancies between Drawings and actual field conditions shall be promptly brought to the Engineer for a decision. No extra compensation will be allowed for changes made by the Contractor without Engineer's consent.
- C. Carefully check and coordinate each device location and elevation. Also check routing of all conduits for conflicts with structures, mechanical piping, ducts, etc. to avoid conflicts.

1.07 REGULATORY REQUIREMENTS

- A. Electrical work, including connection to electrical equipment integral with mechanical equipment, shall be performed in accordance with the latest published regulations of the National Electrical Code (NEC), State and local codes, and according to the latest Institute of Electrical and Electronic Engineers (IEEE); American National Standards Institute (ANSI); American Society for Testing and Materials (ASTM); Insulated Cable Engineers Association (ICEA); National Electrical Manufacturers Association (NEMA) Standards; and the latest published regulations of the Federal Occupational Safety and Health Act (OSHA). When applicable, the material used in the performance of the electrical work shall be listed by the Underwriters' Laboratories, Inc. (UL) for the class of service for which they are intended.

- B. Control panels shall be assembled and wired by a UL 508A recognized panel shop. All control panel components shall be UL recognized or ground fault protected per UL 508A fabrication standards. Each control panel assembly shall be fabricated according to UL 508A Standards and shall bear a serialized UL 508A label.

1.08 WARRANTY

- A. In addition to specific warranties required by the Specifications, the Contractor shall leave the entire installation in complete working order and free from defects in materials, workmanship or finish. Contractor shall repair or replace at his own expense any part that may develop defects due to faulty material or workmanship during the tests and within a period of one year after the work is accepted by the Engineer and Owner. Contractor shall repair or replace existing equipment and work that is damaged during the repair of defective apparatus, materials or workmanship.
- B. All manufacturer's warranties shall be filled out in their entirety by the Contractor for the Owner using the Owner's name and address. Unless otherwise specified, equipment warranty periods will commence on date of final acceptance.

1.09 DRAWINGS

- A. **Clarity and Legibility:** For purposes of clarity and legibility, the Drawings are diagrammatic only. Drawings are not intended to show every fitting, junction, gasket or component necessary, nor every difficulty that may be encountered during installation. Conduit routing may be adjusted in the field. Size and location of equipment are drawn to scale wherever possible. Contractor shall refer to related data in all Contract Documents and shall verify this information on site.
- B. Schematic diagrams are provided to indicate the control strategy intent only. Final circuitry shall be as determined by the Contractor or his vendors. Actual wiring diagrams shall be provided by the Contractor and reviewed by the Engineer for a fully functional system as intended.

1.10 REFERENCES

- A. The specifications reference known standards and codes. Each such standard referred to shall be considered a part of the Specifications to the same extent as if reproduced therein in full. The following is a representative list of such Associations, Institutes and Societies, together with the acronym by which each is identified.

AASHTO	American Assoc of State Highway and Transportation Officials
AIEE	American Institute of Electrical Engineers
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IES	Illumination Engineering Society

NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NETA	National Electrical Testing Association
NFPA	National Fire Protection Association
NTUA	Navajo Tribal Utility Authority
UL	Underwriter's Laboratories, Inc.

- B. Every reference in the Specifications shall mean the latest printed edition of each in effect at the Contract Date.

1.11 UTILITY SERVICE

- A. Contractor shall contact APS to provide the new electrical service to the site. The Contractor shall provide all necessary labor and material required to obtain this service in accordance with utility requirements. Any fees or charges associated with providing, maintaining and usage of these services shall be paid by Owner.
- B. Submit copies of electrical service entrance equipment to APS for approval prior to releasing switchgear for fabrication. A copy of this approval letter shall be submitted to the Engineer.

1.12 ABBREVIATIONS

- A. References on the Drawings to various abbreviations have been made. The following is a representative list of such abbreviations together with the acronym by which each is identified.

AFF	Above finished floor
AFG	Above finished grade
AI	Analog input
AO	Analog output
APS	Arizona Public Service Company
ATS	Automatic transfer switch
C	Conduit
C/B	Circuit Breaker
CKT	Circuit
CPT	Control power transformer
Cu	Copper
DI	Digital input
DIST	Distribution
DO	Digital output
DWG	Drawing
GND	Ground
GFCI	Ground Fault Circuit Interrupter
GFI/GFP	Ground Fault Indication/Protection
GRS	Galvanized Rigid Steel Conduit
HPS	High Pressure Sodium
IMC	Intermediate Metal Conduit
INST	Instrument

LED	Light Emitting Diode
MBJ	Main bonding jumper
MCB	Main Circuit breaker
MCC	Motor Control Center
MCP	Motor Circuit Protector
MFR	Manufacturer
MLO	Main Lug Only
MTS	Manual transfer switch
NC	Normally Closed
NO	Normally Open
NTUA	Navajo Tribal Utility Authority
PC	Personal computer
PLC	Programmable logic controller
PR	Pair
REQ'TS	Requirements
RTU	Remote terminal unit
SES	Service entrance section
SPD	Surge Protective Device
RMC	Rigid Metal Conduit (GRS or IMC)
RVSS	Reduced Voltage Soft Starter
SWBD	Switchboard
TSP	Twisted Shielded Pair
TST	Twisted Shielded Triad
VFD	Variable frequency drive
WP	Weatherproof

****END OF SECTION****

SECTION 16110

RACEWAYS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Metallic and non-metallic wiring raceways.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data demonstrating compliance with this specification including couplings, fittings, bushings, and hangers.
- B. Submit on the proposed method for separating conduits in underground ductbanks.

1.03 QUALITY ASSURANCE

- A. Perform work in accordance with NECA Standard of Installation and NFPA 70.

1.04 RELATED WORK

- A. Specification Section 16195, Electrical Identification

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Conduit:
 - 1. Rigid metal, intermediate and EMT:
 - a. Allied
 - b. Republic
 - c. Triangle Conduit and Cable Co.
 - d. Wheatland
 - 2. PVC coated rigid steel:
 - a. Ocal
 - b. Robroy
 - c. Calbond
 - d. Gafco Green
 - 3. Flexible and flexible water-tight:
 - a. Alflex Corp.
 - b. Carlon Products Corp.
 - c. Carol Cable Co., Inc.
 - d. Electri-Flex
 - e. Sealtite
 - 4. Non-metallic PVC:
 - a. Can-Tex

- b. Carlon
- c. PW Eagle/JM Eagle
- 5. Conduit supports and hangers:
 - a. Caddy
 - b. Thomas and Betts
 - c. Appleton
 - d. Crouse-Hinds
 - e. B-Line Systems
- 6. Supporting Channel:
 - a. G-Strut
 - b. Unistrut
 - c. B-Line

2.02 MATERIALS

- A. Metallic Conduit:
 - 1. Rigid steel:
 - a. Hot dipped galvanized rigid steel; meet ANSI C80.1 and ASTM A153; UL labeled and meet UL Standard No. 6.
 - b. All fittings shall be threaded. Threadless couplings shall not be used unless specifically approved by the Engineer.
 - c. All conduit body covers shall be secured with machine screws threaded onto the conduit body. Covers secured by snaptight or wedge-nuts are unacceptable.
 - d. Where PVC coated rigid steel conduit is indicated on the Drawings, the conduit shall be galvanized steel with a factory installed PVC coating. All conduit fitting, boxes, connectors, etc. shall also be PVC coated by the factory.
 - e. No aluminum conduit shall be permitted unless approved by the Engineer.
 - 2. Intermediate: Shall be same as rigid above with thinner wall.
 - 3. Electrical metallic tubing (EMT or Thin-wall) shall be:
 - a. Galvanized; meet ANSI C80.3; UL labeled; marked with manufacturer's name.
 - b. Thin-wall conduit fittings for damp or wet locations shall be of the regular watertight design, with hexagonal nuts and center portions requiring the use of a wrench during installation.
 - c. Setscrew type fittings are not permitted under any circumstances.
 - 4. Flexible conduit:
 - a. UL-listed flexible rubber or plastic coated metallic type with watertight ferrule and sleeve type connectors. Standard steel type flexible conduit is unacceptable.

- b. ANSI/NEMA FB1 steel connectors. Connectors must be PVC coated where installed in corrosive environments or where PVC conduit or PVC coated GRS conduit is specified.
 - c. Flexible conduit installed in hazardous classified areas shall be explosion-proof or be rated for use in the specified area classification.
- B. Non-Metallic PVC Conduit:
- 1. Rigid non-metallic conduit Polyvinyl Chloride (PVC) type II PVC shall be schedule 40, suitable for use with 90 degree rated wire. Conduit shall bear UL labels for above and below ground use.
 - 2. All PVC conduit 1-1/4 inch and larger with bends greater than 45° shall utilize factory bends.
 - 3. Where the enclosure or raceway is subject to physical damage, conductors shall be installed in rigid metal conduit, intermediate metal conduit, Schedule 80 rigid nonmetallic conduit or equivalent.
 - 4. Meet UL standard #651.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. General:
- 1. Raceways shall be concealed, where possible, unless otherwise indicated on the Drawings. When exposed, confirm the exact routing with the Engineer prior to roughing in.
 - 2. Sizing: Minimum conduit sizes are indicated on the Drawings. The Contractor may choose to install larger conduit for ease of installation or wiring pulling at no additional cost to the Owner. If conduit or raceway size is not indicated on the Drawings, raceways shall be sized per NEC. Unless otherwise indicated, minimum conduit size shall be 3/4 - inches.
 - 3. Unless otherwise indicated, all exposed conduits shall be galvanized steel rigid metal conduit (RMC) or intermediate metal conduit (IMC). All direct buried or concrete encased conduits to be Schedule 40 PVC.
- B. Conduit:
- 1. Conduit shall: Have openings temporarily plugged, using “pennies” or equal, to exclude plaster or other foreign materials; be reamed after cutting; have joints cut square, and butt solidly into fittings; have the ends terminated in a proper bushed fitting, be rigidly supported so as to prevent undue stress or strain on the couplings and connectors; be swabbed before conductors are pulled in.
 - 2. Concealed conduits shall be run in a direct line with long sweep bends and offsets. Horizontal runs shall be run with a slight incline, to prevent low spots or pockets (for drainage).

3. Conduits shall be continuous from outlet to outlet, from outlets to cabinets, pull or junction boxes and shall be secured to boxes with lock nuts and bushings in such a manner that each system shall be electrically continuous throughout. "Erickson" couplings shall be used where required. No running threads shall be cut.
4. Install conduit systems completely before conductors are pulled. Conduits shall be securely supported at proper intervals to structures with steel clamps, or conduit hangers or by special supporting assemblies when indicated on the Drawings.
5. Conduit terminations shall contain insulated bushings. Provide grounding type bushings where steel conduit is stubbed into nonmetallic enclosures, stubbed up in the base of freestanding enclosures or where locknuts cannot assure proper ground continuity between metallic enclosures and the steel conduit. Provide service entrance and transformer connection conduits with grounding type bushings.
6. Exposed conduits shall be installed parallel to walls, floor and ceilings or at right angles to the building lines. Exposed bends shall be used only where approved. Covers shall be secured to bodies with machine screws.
7. Electrical metallic tubing (EMT) or "Thin-wall" may not be used except where specifically indicated on the Drawings or as directed by the Engineer.
8. Hickey bends shall not be used for 1-inch and larger conduits. Either manufactured elbows or bends fabricated in a bending machine shall be used. The radius of the inner edge of bends shall be six times the internal diameter of the conduit for conduit sizes up to 2 ½-inches and 12 times internal diameter for 3-inches conduits and larger. A run of conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than 360° of total bends.
9. Conduit shall not be run above or below water piping, and must be individually supported.
10. In wet locations, and in locations where walls are frequently washed, the entire conduit system, including boxes and fittings used, shall be installed and equipped to prevent water from entering conduit. Conduit shall be so mounted so that there is at least ¼-inch air space between conduit and wall or similar supporting surface.
11. Schedule 40 PVC conduit may be used for buried conduit installations as permitted by the NEC and local codes except where galvanized rigid steel is specified. Couplings, transition fittings, adhesives, primer and installation procedures recommended by the conduit manufacturer and all applicable codes must be strictly followed.
12. Install liquid-tight flexible metal conduit at motors, transformers and equipment which are subject to vibration or require movement for maintenance purposes. Provide necessary reducer where equipment

furnished cannot accept 3/4-inch size flexible conduit. Limit flexible conduit length to 3-foot maximum.

- C. Sleeves, Inserts, etc.: Lay out and install work in advance of the laying or pouring of floors and erection of walls. Furnish and install sleeves that may be required for openings through floors, wall, etc. Where plans call for conduit to be run exposed, furnish and install inserts and clamps for the supporting of conduit. If this Contractor does not properly install sleeves and inserts required, he will be required to do the necessary cutting and patching later, at his own expense, to the satisfaction of the Engineer.
- D. Installation of Underground Conduits:
1. Install underground conduit as indicated on the Drawings. Backfill material around the conduits must be clean-fill (dirt with rocks no larger than 1/2-inch).
 2. Conduit bends shall have long sweep radius curves instead of standard elbows where indicated on the Drawings. All PVC conduit bends greater than 45° shall be factory-made for conduits larger than 1-inch.
 3. All underground PVC conduit shall be buried a minimum of 24-inches below finished grade, except when located below a concrete slab or freestanding electrical equipment. Conduit shall be installed deeper than 24-inches wherever required to avoid existing piping, tunnels, or other obstructions.
 4. Underground conduits in ductbanks shall be separated and supported with pre-manufactured plastic chairs, unless submitted and approved otherwise, installed at 5-foot intervals in the trench.
 5. ***After duct is in place, notify the Engineer prior to backfill for inspection.*** Failure to do so will result in removal of all backfill material to expose the conduits for inspection.
 6. During backfill, provide plastic warning tape at 12-inches below finished grade over underground electrical installations which reads, "Caution - Buried Electrical Line Below".
 7. Any portion of the conduit with less than 24-inches of cover shall be PVC coated rigid metal conduit or galvanized rigid metal conduit wrapped with 20-mil rubber tape half-lapped to a thickness of 40-mils. PVC conduits are permitted to be stubbed up directly into freestanding electrical enclosures.
 8. Where terminating PVC conduit in a freestanding enclosure, underground junction box, manhole/handhole or other similar locations, provide each termination with a bell end.
 9. Rigid metal conduit terminations shall contain insulated bushings. Provide grounding type bushings where steel conduit is stubbed into nonmetallic enclosures, stubbed up in the base of freestanding enclosures or where locknuts cannot assure proper ground continuity between metallic enclosures and the steel conduit. Install grounding type bushings on all service entrance and utility transformer connection conduits.

10. Spare conduits shall be capped with an approved plug.
11. Before pulling cables into underground conduits, pull a mandrel ¼-inch smaller than the conduit inside diameter and pulled through each conduit, and if any concrete or obstructions are found, the Contractor shall remove them and clear the conduits. Underground conduits shall be swabbed before cables are pulled in.
12. After duct runs are completed and set, backfill the trenches and tamp thoroughly to 90 percent compaction.

3.02 CONDUIT MARKERS

- A. All conduits with conduit designations indicated on the Drawings shall be identified at each termination. See Section 16195 - Electrical Identification for conduit tag requirements.

****END OF SECTION****

SECTION 16120
WIRES AND CABLES
(600V OR LESS)

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Cables and wires rated 600 volts or less, as specified, including wiring of all devices.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data on all power, signal and communication cables demonstrating compliance with this Specification.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards:
 - 1. NFPA 70 (NEC)
 - 2. UL listing for materials.
 - 3. ICEA S-66-524
 - 4. NEMA WC-7
 - 5. ASTM B-3 or B-8

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Cable:
 - 1. General Cable
 - 2. Okonite
 - 3. Southwire
 - 4. Encore
- B. Connectors:
 - 1. Ideal
 - 2. Burndy Corp.
 - 3. Thomas and Betts Co.
 - 4. O.Z. Gedney
 - 5. Minnesota Mining & Manufacturing (3M)

2.02 MATERIALS

- A. Conductors for wire and cable shall be stranded copper with 98 percent conductivity and shall be tinned or untinned in accordance with established standards for the type of insulation around the conductors. Solid conductors are not acceptable.

- B. Wire and cable shall be stamped approximately every two feet to indicate voltage, type, temperature rating, and other significant data or warnings.
- C. Conductors for general purpose wiring shall meet the following requirements:
 - 1. Power: Type XHHW-2. Minimum conductor size for power shall be No.12 AWG.
 - 2. Control: Type XHHW-2 for conductors run in conduit, minimum size No.14 AWG. Type MTW for conductors contained in control panels, minimum size No.14 AWG or No.16 AWG when protected by an overcurrent device of 10A or less.
- D. Wire Pulling Lubricant: Lubricant shall be UL listed and be of a consistency that will not leave an obstruction or tackiness that prevents pulling out wires in the future. No soap flakes or vegetable soaps will be permitted. Lubricant in shall be Ideal Wire Lube or equal.
- E. Cable Ties: Wiring in panels, cabinets, etc. shall be neat and tied with “Ty-Rap” T&B “TY-5418” series, or Panduit Co. “Cable Wrap”. Cable ties used in outdoor locations shall be UV stabilized.
- F. Terminations:
 - 1. 3-M Scotchlok lugs and connectors - copper.
 - 2. O-Z solderless connectors, grounding devices, power connectors, armored cable fittings, and cable terminations.
 - 3. Burndy - copper - all types as appropriate for cable size and configuration.
- G. Connector material shall be compatible with conductor material to prevent corroding, differences in coefficients of expansion or electrolysis.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Install wires and cables in NEC approved raceways (Section 16110). All wire and cable must be installed in a raceway, unless otherwise indicated on the Drawings.
- B. Branch circuit and feeder conductors shall have insulation with the following color. Phase tape is unacceptable.
 - 1. Grounding conductor-Green.
 - 2. Neutral - White.
 - 3. 120/240V Phase A - Black.
 - 4. 120/240V Phase B - Red.
 - 5. 277/480V Phase A - Brown.
 - 6. 277/480V Phase B - Orange.
 - 7. 277/480V Phase C - Yellow.
- C. 6-inch minimum loops shall be provided at each outlet, device or luminaire. Unused wires in outlet boxes, shall be rolled up, connected together and taped or

capped with wire nuts. Mark bundled, unused spare wires as “SPARE FROM [origination]”.

- D. Branch circuit sizing: Where wire size is not indicated on the Drawings, NEC and local codes shall govern. However, minimum branch circuit conductor size shall be No. 12 AWG.
- E. Pulling Cables: Wires and cables shall be carefully handled during installation. Lubricant used for pulling in wires and cables shall be used. Use a dynamometer when pulling conductors by mechanical means.
- F. Bending radius: Do not exceed the manufacturer’s maximum bending radius.

3.02 SPLICES AND TERMINATIONS

- A. Splices:
 - 1. Splices in conductors shall not be used unless otherwise indicated on the Drawings or approved by the Engineer.
 - 2. Where splices are allowed or necessary, they shall be mechanically strong and well made so that the electrical resistance of a joint shall not exceed that of 2-feet of the conductor.
 - 3. Splices shall be made only in junction boxes and never in conduit.
 - 4. Above Grade Splices:
 - a. Utilize wing nut solderless connectors for splicing No. 8 AWG and smaller conductors. Follow manufacturer’s recommendations for sizing, stripping, twisting, etc.
 - b. Utilize insulated butt connectors crimped end-to-end for splicing No. 6 AWG and larger conductors. Follow manufacturer’s recommendations for sizing, stripping and crimping.
 - 5. Below Grade Splices:
 - a. Utilize waterproof splice kits or wing nut solderless connectors with cast-resin waterproofing for splicing No. 8 AWG and smaller conductors. Follow manufacturer’s recommendations for sizing, stripping, twisting, etc.
 - b. Utilize insulated butt connectors crimped end-to-end with cast-resin waterproofing for splicing No. 6 AWG and larger conductors. Follow manufacturer’s recommendations for sizing, stripping and crimping.
 - c. Utilize insulated butt connectors crimped end-to-end for all below grade splices or No. 6 AWG and larger conductor splices above grade. Follow manufacturer’s recommendations for sizing, stripping and crimping.
- B. Motor terminations: Ring type, crimped connectors shall be installed on all conductors and bolted together back-to-back. For terminations with No.6 and smaller wire, use 10-24 bolts. Use bolts that match the connector bolthole size for all other motor terminations. Apply one layer of cambric tape followed by three layers of rubber tape and finally, top with one layer of black vinyl tape.

- C. Non-motor terminations: Use ring or fork type, crimped connectors for all screw-on terminations. Wrapping wire around a binding post is unacceptable.
- D. Where special tools are required to properly install the particular connector the special tools must be used.

3.03 WIRE MARKERS

- A. All conductors shall be labeled at each termination and splice. See Section 16195 - Electrical Identification for wire marker requirements.

****END OF SECTION****

SECTION 16130

BOXES

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Outlet boxes, pull and junction boxes and underground junction boxes.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data for standard outlet boxes up to six gang, including floor type demonstrating compliance with specification requirements and Drawings.
- B. Shop Drawings: Submit drawings for special pull, outlet, and junction boxes demonstrating compliance with NEC and specification requirements. Drawings shall indicate box dimensions and locations in building.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards:
 - 1. NEMA 250
 - 2. NFPA 70
 - 3. UL listing for materials.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Appleton Electric
- B. Crouse-Hinds
- C. Killark
- D. Raco
- E. Hoffman Engineering Co.
- F. O.Z. Gedney Co.
- G. Steel City
- H. Hubbell
- I. Rittal

2.02 MATERIALS

- A. Outlet boxes for concealed conduits and flush-mounted wiring devices shall meet the following requirements:

1. Stamped, one piece, galvanized steel.
 2. Proper size and shape for conduits entering them.
 3. UL listed for their application.
 4. ANSI/NEMA OS-1 for galvanized steel; ANSI/NEMA OS-2 for non-metallic.
- B. Outlet boxes for exposed conduit systems and exterior locations shall be of the threaded-hub, cast-metal, conduit type fitting suitable for the wiring devices to be installed. Covers (blank, switch, receptacle, etc.) shall be the type specifically designed to fit the specified boxes.
- C. Above grade electrical junction and pull boxes shall be sheet metal with an ANSI 61 gray color with size and type as indicated on the Drawings. NEMA rating shall be as indicated on the Drawings. Where a NEMA rating is not indicated, outdoor boxes shall be NEMA 3R and indoor boxes shall be NEMA 12. Box sizes shall be as indicated on the Drawings. Where sizes are not indicated or larger size is required to meet code, the box size shall be increased as required by the National Electrical Code.
- D. Wireways:
1. Wireways shall be sized as indicated on the Drawings or as required by the National Electrical Code. Where sizes are not indicated or larger size is required to meet code, the wireway shall be sized such that the cross-sectional area of the wireway at any one point does not exceed 40% per the National Electrical Code.
 2. Cover: Hinged with removable latches where feasible.
 3. UL listed for steel enclosed wireway or auxiliary gutter.
 4. Furnished complete with covers, elbows, tees, junction boxes, end covers, connectors and hangers.
 5. Unless otherwise indicated, wireways shall be NEMA 3R.
 6. Wireways in outdoor locations shall be fully gasketed.
- E. Underground junction boxes:
1. Construction: Electric underground junction boxes shall be precast concrete and size as indicated on the Drawings. Underground junction boxes shall have precast concrete extensions.
 2. Covers: Covers shall be rectangular, reinforced concrete and have the text "ELECTRIC" cast into the cover.
 3. Approved Manufacturer: Christy, or equal.
- F. Fittings, hangers, fastenings, etc., shall be of material that will prevent chemical reaction between itself and conduit or device it is fastening or supporting.

PART 3 -- EXECUTION

3.01 BOX LOCATIONS

- A. Location of Boxes: In order that boxes may be placed in proper locations, the Contractor shall familiarize himself with the details of these spaces and carefully lay out boxes so that the equipment or piping of other trades passing under, over, across or in close proximity to same, will not cause these boxes to be inaccessible for use or maintenance. Contractor shall consult with other Contractors and trades on the project and obtain details of the project to locate outlet boxes properly.
- B. Contractor shall be responsible for the exact and proper location of the various portions of his work. Consult the Drawing and details.

3.02 INSTALLATION

- A. No thru-boxes shall be permitted.
- B. Boxes shall meet the following requirements:
 - 1. Proper size and shape for conduits entering them.
 - 2. Installed so that device and/or cover plates shall be tight and plumb with wall finish.
 - 3. Have unused openings closed with knock-out closures.
 - 4. Securely fastened to building or structure.
- C. Surface-mounted outlet boxes shall meet the following requirements:
 - 1. Outdoor boxes shall be cast steel or cast aluminum with threaded hubs.
 - a. Fastened with not less than two Paine, Phillips, Ackermann-Johnson, or equivalent, screw anchors and round head machine screws on brick and concrete walls or ceilings.
 - b. Under no circumstances will drilling of cast boxes be allowed.
 - c. PVC coated boxes shall be used for installations with PVC coated rigid steel conduit.
 - d. Be provided with a vapor-proof gasket in wet locations or where indicated as "WP" (weatherproof) on the Drawings.
 - e. Install a weatherproof-while-in-use cover on all outdoor receptacles.
 - 2. Bell boxes may be used for indoor applications where rigid steel or IMC conduit is required.
- D. Flush-mounted outlet boxes shall:
 - 1. Be solid ganged boxes for more than two devices.
 - 2. Contain a plaster ring to bring the wiring device attachment points within ¼-inch of the finished wall surface.
 - 3. Be installed so that device covers are tight and plumb with wall finish.
 - 4. Be installed as close as possible to the lock side of door trim for light switches.
- E. Bracket outlets shall be level and centered on columns or above doors when installed in these locations.

- F. Pull boxes and junction boxes shall be:
1. Installed where indicated on the Drawings or where necessary to not exceed 360 degrees of conduit bends.
 2. Entirely accessible.
 3. Securely mounted to building structure independent of the conduits connected to them.

****END OF SECTION****

SECTION 16140
WIRING DEVICES

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Wiring devices such as but not necessarily limited to receptacles and light switches.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data for each wiring device including device covers demonstrating compliance with these Specifications and UL labeling.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and standards:
 - 1. NEMA
 - 2. UL listing
 - 3. NFPA 70

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Hubbell
- B. Leviton
- C. Bryant
- D. Crouse-Hinds
- E. Pass & Seymour

2.02 MATERIALS

- A. Light switches and receptacles shall meet NEMA WD1 and WD6 standards, be UL listed and be Heavy Duty, **Industrial** Specification grade. Commercial specification grade wiring devices are not acceptable.
- B. Amperage rating of each wiring device shall match the circuit's overcurrent device amperage rating to which it is connected.
- C. Wiring devices shall have an ivory finish unless otherwise specified.
- D. Power receptacles shall be the grounded type. Furnish ground fault circuit interrupter (GFCI) type where indicated on the Drawings or as required by the NEC.
- E. All GFCI receptacles shall be listed weather-resistance (WR) type receptacles.
- F. Light switches shall be the quiet type.

- G. Wiring Device Coverplates:
1. Unless otherwise indicated, coverplates installed indoors or in control panels shall be brushed anodized aluminum.
 2. Weatherproof locations: Wiring devices installed outdoors or where identified on Drawings with “WP” shall contain a gasketed coverplate UL approved for wet locations.
 3. Where weatherproof-while-in-use coverplates are indicated on the Drawings or required by NEC, power receptacles shall be provided with a cover that is listed for “extra duty” and maintains UL approval for wet locations when a cord is plugged into the receptacle.

PART 3 -- EXECUTION

3.01 INSTALLATION/APPLICATION

- A. Devices and coverplates shall be plumb and parallel to adjacent surfaces or trim. Flush-mounted devices must be flush with finished wall surfaces and the coverplates must be tight to surfaces over which they are installed.
- B. Receptacles identified as GFCI or when required by the NEC shall have individual GFCI receptacles installed for each outlet.

****END OF SECTION****

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 -- GENERAL

1.01 SECTION INCLUDES

- A. Nameplates and labels
- B. Wire and cable markers
- C. Conduit markers

1.02 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code.
 - 1. NEC 110-22 Identification of Disconnecting Means
 - 2. NEC 200-6 Means of Identifying Grounded Conductors
 - 3. NEC 200-10 Identification of Terminals
 - 4. NEC 210-5 Identification for Branch Circuits
 - 5. NEC 215-8 Means of Identifying Conductor with the Higher Voltage to Ground
 - 6. NEC 230-70, (B) Service Equipment, Marking
 - 7. NEC 310-11 Marking
 - 8. NEC 310-12 Conductor Identification
 - 9. NEC 400-22 Grounded-Conductor Identification
 - 10. NEC 400-23 Equipment Grounding Conductor Identification
 - 11. NEC 408-13 Panelboard circuit identification
- B. UL standard 224- Standard for Extruded Thermoplastic Insulating Tubing.

1.03 SUBMITTALS

- A. Product Data: Provide catalog data for the following:
 - 1. Wire and cable marking system
 - 2. Nameplate materials and fasteners
 - 3. Conduit markers

1.04 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

PART 2 -- PRODUCTS

2.01 NAMEPLATES AND LABELS

- A. Engraved laminated plastic nameplates with black letters on white background shall be installed on the following as a minimum:
 - 1. Electrical distribution equipment enclosures
 - 2. Disconnect switches and motor controllers
 - 3. Control panels and cabinets
 - 4. Each motor controller or control panel door mounted device
 - 5. Major components, control relays and terminal block strips mounted on the backpanel of control panels
- B. Letter Size:
 - 1. Use 3/8-inch letters for identifying electrical distribution equipment enclosures and other large control panels and cabinets. Use 3/16-inch letters for identifying individual control panel components (inside or out) and small control panels/enclosures.

2.02 WIRE MARKERS

- A. Manufacturer: Raychem Corporation Model ShrinkMark or equal.
- B. Description: heat shrinkable radiation cross-linked, thermally stabilized, modified polyolefin sleeves with 3:1 shrink ratio. Markers shall be UL Standard 224 recognized.
- C. Sleeves shall be smear resistant prior to shrinking and achieve mark permanency when shrunk without the need for permatizing equipment. Sleeves should achieve mark permanency when standard ballpoint pens or high-carbon content fabric ribbons are used. The markers shall be flattened and mounted on a carrier suitable for use with commercially available print equipment. Markers shall be printable on both sides. Markers shall be resistant to common industrial fluids including Freon TF, Isopropyl alcohol, and Ethylene Glycol.
- D. Locations: Each conductor at each termination and splice.
- E. Legend:
 - 1. Power and Lighting Circuits: Branch circuit or feeder number indicated on the Drawings.
 - 2. Control Circuits: Control wire number indicated on approved schematics, interconnection diagrams and shop drawings.
 - 3. Wire numbers shall be the same at both ends of the wire.

2.03 CONDUIT MARKERS

- A. Furnish and install conduit markers on ends of each conduit run and in intermediate locations such as manholes and handholes. Conduit markers shall be 19 gauge, 1 1/2-inch diameter round brass with backfilled legend, Style #250-BL as manufactured by Seton Nameplate Corporation or equal. Marker shall identify conduit as indicated on the Drawings. If a conduit is not identified on the Drawings, the Contractor shall consult the Engineer for the proper identification.

PART 3 -- EXECUTION

3.01 NAMEPLATES

- A. Install nameplates parallel to equipment lines.
- B. Secure nameplates to the exterior of electrical equipment using UL-508A approved die and tapped stainless steel screws (APM SEELSKREW or equal).
- C. Secure nameplate to inside surface or backpanels of control panels with a permanent adhesive (Liquid Nails or equal).

3.02 WIRE MARKERS

- A. Wire markers shall be a minimum of 3/8-inches in length and placed as near as possible to the end of the wire. Orient wire marker such that the writing can be read without turning or twisting the wire.
- B. Wire numbers shall be the same at both ends of the wire.

3.03 CONDUIT MARKERS

- A. Attach markers near the end of exposed conduits with stainless steel tie-wire.
- B. Secure conduit markers to the floor using a permanent epoxy where conduits terminate in bell ends flush with finished floor in freestanding equipment.

****END OF SECTION****

SECTION 16261
MANUAL TRANSFER SWITCH

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: DPDT manual transfer switch, 600V and below with accessories as indicated herein.

1.02 SUBMITTALS

- A. Submit the following:
1. Product Data: Provide catalog data on all components in accordance with this specification.
- B. Shop Drawings shall contain the following data:
1. Name of motor(s) or load(s) being served.
 2. Horsepower and current rating.
 3. Voltage rating.
 4. Number of poles and wires.
 5. Enclosure NEMA rating.
 6. Enclosure dimensions.
 7. Lug quantity and wire size range.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards:
1. UL listing and labeling for materials.
 2. UL 1008
 3. NFPA-70.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Square D Company
- B. General Electric Company
- C. Siemens
- D. Eaton

2.02 MATERIALS

- A. Manual transfer switches shall be:
1. Fused, non-fused or circuit breaker style with voltage, amperage and number of poles/wires as indicated on the Drawings.
 2. Heavy-duty rated.

3. DPDT with a center OFF position.
4. Horsepower rated at 250 volts AC or DC, or 600 volt AC whichever is applicable.
5. Capable of interrupting locked rotor current of the motor horsepower rating of the switch (assumed current of six times the rated full load current).
6. Clearly labeled to indicate switch position without opening the enclosure door. Labels shall be done with nameplates fastened to the enclosure door to indicated “Utility”, “Off” and “Generator”
7. Dead-front construction with permanently attached arc suppresser.
8. UL listed removable lugs for copper and/or aluminum cable and front accessible.
9. Furnished with NEMA rated enclosures as indicated on the Drawings. Enclosures shall be constructed of sheet steel.
10. Enclosure doors shall be interlocked to prevent them from being opened when in either ON position.
11. The short circuit withstand ampacity shall be 10,000 AIC unless otherwise indicated on the Drawings.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Install where indicated on plans. Mount unit such that it is level and plumb, and in accordance with manufacturer’s directions.
- B. Prior to installation, coordinate with other trades to verify conduits have adequate space to leave and enter the transfer switch enclosure and for required code clearance. A minimum working clearance as defined by the NEC 110-26 shall be provided.
- C. Install in accordance with NFPA 70 and all applicable local codes and regulations.

****END OF SECTION****

SECTION 16400
FREESTANDING
SERVICE ENTRANCE SECTION

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Freestanding electrical service entrance section and service disconnect.

1.02 SUBMITTALS

- A. Product Data: Submit catalog cuts and manufacturer's descriptive literature for approval for:
1. Service Entrance Sections
 2. Service Disconnect
- B. Shop Drawings:
1. Submit drawings showing dimensions and dimensional clearances within the structure.
 2. Include metering, ground fault protection, if required; breaker/fusing, dimensioned bus locations, digital metering and instrument transformers.
 3. Submit single line diagram and any associated schematic and wiring diagrams for equipment in the service and distribution equipment.
 4. All electrical characteristics (voltage, phasing, amperage, bracing, interrupting capacity).
- C. Serving electric utility company coordination:
1. The Contractor shall submit the above listed information to the serving utility company for approval of proposed service entrance equipment. The Contractor shall submit written approval from the serving utility company to the Engineer.

1.03 QUALITY ASSURANCE

- A. Meet requirements of NEC (NFPA 70)
- B. Codes and Standards:
1. NFPA 70-NEC
 2. NEMA
 3. U.L. listed
 4. ICEA
 5. IEEE
 6. ANSI
 7. Local utility company

- C. Service equipment shall bear markings “Suitable for Use as Service Equipment” or be UL listed as “Service Equipment.”
- D. The manufacturer of the service entrance equipment shall be the manufacturer of the circuit protective devices, and other accessories within.
- E. The manufacturer of the service entrance equipment shall be ISO 9000, 9001 or 9002 certified.
- F. The manufacturer of the service entrance equipment shall have produced similar electrical equipment for a minimum period of five (5) years. If requested by the Engineer, a list of installations with successful operation of similar equipment shall be provided demonstrating compliance with this requirement.

1.04 RELATED WORK

- A. Section 16195 – Electrical Identification
- B. Section 16425 – Distribution Switchboards

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Eaton
- B. Schneider
- C. General Electric Co.
- D. Siemens

2.02 GENERAL CONSTRUCTION

- A. The equipment specified herein shall have the following ratings:
 - 1. Voltage: As indicated on the Drawings
 - 2. Phasing: As indicated on the Drawings
 - 3. Alternating Current Frequency: 60 Hz
 - 4. Bus Bracing: As indicated on the Drawings
 - 5. Bus Amperage: As indicated on the Drawings
 - 6. Protective Device Mounting: Fixed
 - 7. Enclosure: Freestanding, NEMA 3R
- B. The service equipment shall consist of the required number of vertical sections bolted together to form a rigid assembly. The internal components and bussing shall be completely enclosed with dead front construction. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.
- C. All sections of the equipment shall be rear aligned. All protective devices shall be group mounted. Devices shall be front removable and load connections front accessible enabling assembly to be mounted against a wall.

- D. All bus bars shall be silver or tin plated copper. Main horizontal bus bars shall be mounted with all phases arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria of 65°C over a 40°C ambient (outside of the enclosure).
- E. The service entrance section main circuit breaker shall be connected to the distribution section main lugs with cables, not bussing.
- F. Provide a full capacity neutral bus.
- G. An appropriately sized copper ground bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the assembly. Ground conductors shall be attached to the bus by means of mechanical type lugs.
- H. All hardware used on conductors shall be high-tensile strength and zinc plated. All bus joints shall be provided with conical spring type washers.
- I. Small wiring, necessary fuse blocks and terminal blocks within the assembly shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
- J. Mechanical type terminals shall be provided for all line and load terminations suitable for copper cable rated for 75°C.
- K. Assembly shall be furnished with an underground incoming line section as indicated on the Drawings and a separate barriered-off utility metering compartment complete with hinged sealable door(s). Bus work shall include provisions for mounting utility company current transformers and potential taps or transformers as required. Lugs shall be provided in the incoming line section for connection of the serving utility's cables.
- L. Provide stamped steel manufacturer's master nameplate(s) on the exterior door that identifies the assembly's designation, voltage, phasing, amperage, short circuit rating, manufacturer's name, general order number and item number. Secure nameplate(s) to exterior door using stainless steel, self-tapping screws.
- M. All exterior and interior steel surfaces of the assembly shall be properly cleaned and provided with a rust-inhibiting phosphatizing coating. Color and finish shall be ANSI 61, unless noted otherwise.

2.03 CIRCUIT BREAKER TYPE PROTECTIVE DEVICES

- A. Circuit breakers shall be of the molded case type.
- B. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy, and arc extinction shall be accomplished by means of arc chutes.

- C. Circuit breakers shall have a minimum symmetrical interruption capacity as indicated on the Drawings.
- D. Circuit breakers shall be equipped with a microprocessor-based sensing trip unit with the following features as a minimum:
 - 1. Each tripping system shall consist of three current sensors, a trip unit, and a flux transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection function. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached.
 - 2. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
 - 3. The microprocessor-based trip unit shall have thermal memory capabilities to prevent the breaker from being reset following an overload condition until after a preset time delay.
 - 4. When the adjustable instantaneous setting is omitted, the trip unit shall be provided with an instantaneous override. Internal ground fault protection adjustable pick-up ratings shall not exceed 1200 amperes. Provide neutral ground fault current sensor for four-wire loads.
 - 5. Breakers shall have built-in test points for testing the long time delay, instantaneous, and ground fault functions of the breaker by means of a 120 volt operated test set.
 - 6. System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments: Long time pick-up and delay; Short time pick-up and delay with selective curve shaping; Instantaneous pick-up; Ground fault pick-up and delay with selective curve shaping.
- E. The Contractor shall be responsible for the setting of the adjustable protective parameters of the circuit breakers to ensure proper system protection and coordination.

2.04 ARC FLASH WARNING LABEL

- A. Furnish each service entrance section with an Arc Flash Warning label to read:

“WARNING
Arc Flash and Shock Hazard
Appropriate (PPE) Required”

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. The Contractor shall provide the services of a qualified and certified factory-trained manufacturer's representative as necessary for assistance in the installation and start-up of the equipment specified herein. The representative shall provide technical direction and assistance in making adjustments and testing of the equipment.
- B. Furnish and install service entrance equipment as indicated on the Drawings, in accordance with the serving utility's requirements, in accordance with the NEC and all applicable local codes and regulations.
- C. Install main bonding jumper and provide grounding of service entrance equipment per the NEC, serving utility and applicable local code requirements.
- D. Before energizing, perform the following tasks:
 - 1. Remove all scraps of wire, dust, dirt and any other foreign material.
 - 2. Inspect the switchgear for proper installation as recommended in the manufacturer's installation instructions furnished with the gear. Inspect all bus bolts and cable connections to insure that they are tight and terminated properly. Inspect all overcurrent devices for damage and look for components that may have loosened during shipment.
 - 3. Meggar testing: Open all overcurrent devices and remove all instrumentation and control fuses. Use a megohmmeter developing 500 volts to test the switchgear. A minimum of 100-megaohms of resistance must be measured from each phase to ground. Any readings less than this will require the manufacturer to inspect the switchgear and replace or make the necessary repairs.

****END OF SECTION****

SECTION 16425

DISTRIBUTION SWITCHBOARDS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Distribution switchboards and related equipment.

1.02 SUBMITTALS

- A. Shop Drawings: Submit drawings showing dimensions, construction and materials. Include specific information for each piece of equipment including, but not limited to, the following items:
 - 1. Distribution Switchboard
 - 2. Surge Protective Device (SPD)
- B. Product Data: Submit manufacturer's data on switchboards including the following:
 - 1. Voltage characteristics.
 - 2. Number of phases.
 - 3. Frequency.
 - 4. Short-circuit and continuous current ratings.
 - 5. Main and branch overcurrent device sizes and A.I.C. ratings.
 - 6. Section dimensions.
 - 7. Bussing.
 - 8. Insulation level.
 - 9. Type of labels and labeling for every device and what it feeds.

1.03 RELATED WORK

- A. Section 16195 – Electrical Identification
- B. Section 16400 – Freestanding Service Entrance Section
- C. Section 16461 – Transformers (Dry-Type)
- D. Section 16470 – Panelboards
- E. Section 16475 – Overcurrent Protective Devices

1.04 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (refer to Section 16010):
 - 1. NFPA 70 (NEC)
 - 2. NEMA PB-2
 - 3. UL 891 and be UL listed.
 - 4. ICEA
 - 5. IEEE

6. ANSI

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Schneider
- B. General Electric Co.
- C. Eaton
- D. Siemens

2.02 SWITCHBOARDS

- A. Construction:
 - 1. Switchboard shall be assembled with the service entrance section as a continuous bussed structure including the automatic transfer switch.
 - 2. Switchboards shall be furnished with group mounted overcurrent protective devices, automatic transfer switch, panelboard and transformer. Refer to other Specifications Sections contained in Division 16 for additional information.
 - 3. Switchboard shall contain the required number of vertical sections bolted together to form one metal-enclosed switchboard not more than 90-inches high. Sides, top and rear covers shall be code gage steel, bolted to the switchboard structure. The frame structure members shall be die-formed steel bolted together and reinforced at external corners with rugged gussets internal and external to the structure members.
 - 4. Enclosure shall be NEMA 3R, freestanding for installation outdoors as indicated on the Drawings.
 - 5. Vertical sections comprising the switchboard shall be rear-aligned.
 - 6. Furnish with adequate lifting means, and be capable of being rolled or moved into installation position and bolted directly to the floor without the use of floor sills.
 - 7. Provide stamped steel manufacturer's master nameplate(s) on the exterior door that identifies the assembly's designation, voltage, phasing, amperage, short circuit rating, manufacturer's name, general order number and item number. Secure nameplate(s) to exterior door using stainless steel screws, APM SEELSKREW or equal
- B. Devices:
 - 1. Provide switchboard with devices as indicated on the Drawings. Each device shall have a quick-make, quick-break externally operated handle that can be locked in "on" or "off" position.
 - 2. A full-height,
 - 3. 36" wide space shall be provided for a future automatic transfer switch.

4. The service entrance section main circuit breaker shall be connected to the distribution section main lugs with cables, not bussing.

C. Bus Bars:

1. All bus bars shall be copper, nested in individual extruded channels in a fiberglass base, to provide a barrier between phases. Bus joints shall be bolted with high tensile steel bolts. Bus joints shall be accessible from the rear of the switchboard for maintenance.
2. Bus bars shall be braced to withstand short circuit mechanical forces of not less RMS symmetrical amps as indicated on the Drawings.
3. Current density of the phase and neutral busses shall not exceed 1,000 amperes per square inch cross-section. Continuous current rating of the bus shall be equivalent to the switch size rating of the main device(s).
4. Feeder device line and load connection straps shall be rated to carry the full continuous current rating of the device switch (not trip rating). Load connection straps shall be insulated and extended beyond the main bus.
5. Ground Bus: Furnish not smaller than ¼ in. x 2 in. copper ground bus secured to each vertical section structure, and extended the entire length of the switchboard.
6. Bus Arrangement: A-B-C type bus arrangement (left- to-right, top-to-bottom, front-to-rear) shall be used throughout to assure convenient and safe testing and maintenance.

D. Wiring:

1. Internal Interlocking and Control Wiring: Fuse blocks and terminal blocks are to be furnished as required within the switchboard. Group control wires leaving the switchboard with terminal blocks and numbered terminal strips.
2. Lugs: Cable connectors shall be mechanical type tin- plated and U/L listed for aluminum or copper cables. See Section 16120.

E. Finish:

1. Steel surfaces shall be chemically cleaned and treated, providing a bond between paint and metal surfaces to help prevent the entrance of moisture and formation of rust under the paint film. Switchboard exterior is to be finished with ANSI61 light gray paint.

2.03 SURGE PROTECTIVE DEVICE (SPD)

- A. The switchgear shall be furnished with an SPD specifically designed for mounting in the switchboard. The unit shall have the following features and functions:
1. UL 1449, 3rd Edition listed
 2. UL 1283 listed
 3. Minimum Surge Current Rating shall be as indicated on the Drawings.
 4. Modes of protection: L-L, L-G, L-N, N-G

5. The maximum UL listed voltage protective rating (VPR) for each mode of protection shall not exceed the following:

<u>Mode</u>	<u>277/480</u>
Line-Neutral	<u>1200</u> VAC
Line-Ground	<u>1200</u> VAC
Neutral-Gnd	<u>1200</u> VAC
Line-Line	<u>2000</u> VAC

6. Status pilot lights, Form C relay contact, EMI/RFI filtering (50dB noise attenuation from 10kHz to 100MHz), and surge counter
 7. Minimum 10 year warranty
- B. Acceptable manufacturers:
1. Schneider Surgelogic Series
 2. Eaton PSPD Series
 3. Siemens TPS3 Series
 4. Or equal

2.04 ARC FLASH WARNING LABEL

- A. Furnish distribution switchboard with an Arc Flash Warning labels on each section to read:

“WARNING
Arc Flash and Shock Hazard
Appropriate (PPE) Required”

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Install switchboards in strict accordance with manufacturer’s instructions.
- B. Provide sections for the future automatic transfer switch, panelboard and transformer as indicated on the Drawings. These sections shall be assembled by the switchboard manufacturer and conform to other Specifications Sections contained in Division 16. Coordinate with vendors of other equipment for proper size of each section.
- C. Install the panelboard and SPD behind inner doors (panels). These inner doors (panels) shall be hinged and able to be opened without the use of tools.
- D. Before energizing, perform the following tasks:
 1. Remove all scraps of wire, dust, dirt and any other foreign material.
 2. Inspect the switchboard for proper installation as recommended in the manufacturer’s installation instructions furnished with the gear. Inspect all bus bolts and cable connections to insure that they are tight and terminated

properly. Inspect all overcurrent devices for damage and look for components that may have loosened during shipment.

3. Meggar testing: Open all overcurrent devices and remove all instrumentation and control fuses. Use a megohmmeter developing 500 volts to test the switchgear. A minimum of 100-megaohms of resistance must be measured from each phase to ground. Any readings less than this will require the manufacturer to inspect the switchgear and replace or make the necessary repairs.

****END OF SECTION****

SECTION 16450

GROUNDING

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Grounding and bonding of electrical equipment, raceways and specialized systems, including testing.

1.02 SUBMITTALS

- A. Manufacturer's data for the following:
 1. Connection methods
 2. Ground rods
 3. Ground rod wells

1.03 SYSTEM DESCRIPTION

- A. Ground electrical equipment, conduits, supports, cabinets, and switchgear in accordance with NFPA 70 (NEC) and as shown on the Drawings, the intent being a system ground and an equipment ground.

1.04 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (refer to Section 16010):
 1. IEEE 81-1962--IEEE Recommended Guide for Measuring Ground Resistance and Potential Gradients in the Earth.
 2. NFPA 70 (NEC)
 3. NEMA
 4. UL listing
 5. MIL Handbook 419

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Ground Rods:
 1. Anderson Electric Corp.
 2. Copperweld Corp.
 3. Harger

2.02 MATERIALS

- A. Ground rods shall be copperclad rods $\frac{3}{4}$ -inch in diameter and 10-feet long unless indicated otherwise on the Drawings.
- B. Ground rod wells shall be $8\frac{1}{2}$ -inch diameter constructed of reinforced concrete with a reinforced concrete removable cover stamped "GROUND" as manufactured by Christy or equal.

- C. Connectors, mechanical lugs or wire terminals shall be used only to bond ground wires, junction and panel boxes.
- D. Grounding conductors shall be stranded copper, size as indicated on the Drawings or as required by the NEC. Grounding conductors shall be bare or contain green insulation.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Where mechanical lugs are not welded or fastened with a threaded bolt, surfaces shall be thoroughly cleaned and paint scraped to bare metal before connections are made to insure good metal-to-metal contact.
- B. An equipment grounding conductor must be installed in each conduit with power conductors or, in the case of multi-conductor cable, run inside the cable sheath.
- C. The Contractor shall bond the electrical equipment pad rebar to the service grounding electrode system.
- D. A main system ground, bare copper conductors, size as indicated, shall be run in PVC conduit from the service entrance section to the grounding electrode system as indicated on the Drawings.
- E. Connections to ground rods shall be exothermically welded. Ground rod connections shall be done in a ground rod well for inspection purposes. Ground rod connections may also be done with Burndy "HYTAP" type connectors.
- F. All enclosure doors with 120V mounted devices shall be bonded to the enclosure ground bus.

****END OF SECTION****

SECTION 16461
TRANSFORMERS
(DRY-TYPE)

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Dry-type transformers.

1.02 SUBMITTALS

- A. Shop Drawings: Submit shop drawings indicating outline dimensions, connection and support points, weight, specified ratings and materials, design test, UL listing, and options being provided. Show spatial relationship to adjacent equipment and structures.
- B. Product Data: Submit wiring diagram with protection and control diagram. Clearly differentiate between wiring that is factory installed and portions to be field installed.
- C. Certificates: Furnish the User's Representative with certified high potential test reports performed on each transformer winding at the manufacturer's facilities prior to transformer shipment.

1.03 QUALIFICATIONS

- A. The manufacturer of the transformer shall be the manufacturer of the distribution switchboard.

1.04 REGULATORY REQUIREMENTS

- A. All transformers shall be UL-listed and shall bear the UL label.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Eaton
- B. Schneider
- C. General Electric Co.
- D. Siemens

2.02 GENERAL PURPOSE TRANSFORMERS

- A. KVA and voltage ratings shall be as indicated on the Drawings. Six voltage taps shall be provided; two above and four below nominal voltage in 2.5% increments.
- B. Transformers shall be designed for continuous operation at rated KVA, for 24 hours a day, 365 days a year operations, with normal life expectancy as defined in ANSI C57.96.
- C. Sound Output: Sound outputs of transformers shall not exceed the following levels, based on NEMA standard testing procedures:

<u>KVA Rating</u>	<u>Decibel Sound Output</u>
0 - 9	40
10 - 50	45
51 - 150	50
151 - 300	55
301 - 500	60

- D. Insulation system: Transformers shall be insulated with a 220°C insulation system based upon 115°C rise.
- E. Required performance shall be obtained without exceeding the applicable temperature rise in a 40 degrees C maximum ambient. All insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM Standard Test Method D635.
- F. Transformer core shall be constructed with high-grade, nonaging, silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point. The transformer core volume shall allow efficient transformer operation at 10 percent above the highest tap voltage. The core laminations shall be tightly clamped and compressed. Coils shall be wound of electrical grade aluminum with continuous wound construction.
- G. External cable shall be rated 90°C for encapsulated type and 75°C for ventilated type designs. Connectors shall be provided for cable sizes as indicated on the Drawings. The core of the transformer shall be grounded to the enclosure.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Transformers shall be installed in a blank section of the distribution switchboard by the distribution switchboard manufacturer.

3.02 ADJUSTING

- A. Adjust primary taps so that secondary voltage is within 2 percent of rated voltage.

****END OF SECTION****

SECTION 16470
PANELBOARDS

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Lighting and power distribution panelboards as indicated on the Drawings and as specified herein.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data demonstrating compliance with this specification and the Drawings. Information shall include but not be limited to:
 - 1. A panel schedule indicating branch circuit number, size and type of individual circuit breakers, interrupting capacity of the device and number of poles.
 - 2. Short circuit current bracing of the panel.
 - 3. Bus material and mounting type.
 - 4. Demonstrate means of identification of each circuit and of each panel by mark corresponding to the Drawings. Explain any deviations.
 - 5. Clearly indicate all dimensions and that it has been verified that the equipment will fit into place.
 - 6. Indicate ground bus kits.
- B. Test Data: Submit test reports on integrated panel.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (refer to Section 16010):
 - 1. NEMA
 - 2. UL listing
 - 3. NFPA 70 (NEC)
 - 4. W-P-115a Power Distribution, current edition

1.04 RELATED WORK

- A. Section 16010 – Basic Electrical Requirements
- B. Section 16195 – Electrical Identification
- C. Section 16450 - Grounding
- D. Section 16475 – Overcurrent Protective Devices

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Square D Company
- B. Eaton

- C. General Electric Co.
- D. Siemens

2.02 MATERIALS

- A. Panelboards shall have the following minimum requirements:
 - 1. UL listed with copper bus bars of 98 percent conductivity and minimum cross sectional area based on UL 67 for heat rise. Bus size and ratings shall be in accordance with UL 67. Minimum bus voltage, amperage and short circuit withstand rating shall be as indicated on the Drawings or as required per NEC.
 - 2. Copper bars shall be provided for terminating equipment grounding conductors and neutral conductors, where applicable.
 - 3. Terminals shall be UL rated for use with copper or aluminum conductors.
 - 4. Panelboards shall include a main circuit breaker or solderless main lugs as indicated on the Drawings. Lugs for main lug only panelboards shall be sized to accommodate the incoming power supply conductors.
 - 5. Fully rated feed-thru lugs shall be provided where indicated.
 - 6. Branch breakers shall be the bolt-on type, unless otherwise indicated.
 - 7. A framed directory pocket shall be provided on the inside door with 1/16-inch thick glass or plastic cover and typed written directory card.
 - 8. A manufacturer's stamped steel nameplate shall be riveted to the exterior indicating voltage, amperage, phases and short circuit bracing.
 - 9. Where indicated, circuit breakers shall have a fixed handle padlock attachment capable of locking the circuit breaker in the off position.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. A minimum working clearance as defined by the NEC 110-26 shall be provided. Whether the panelboard is installed indoors or outdoors, the working space as defined in Table 110-26(a) of the NEC shall apply.
- B. Panelboards shall be installed such that the highest circuit breaker handle is not more than 6'-7" above finished floor.
- C. Provide a means of keeping unauthorized hands out of live panels during construction when panelboard fronts have not been installed.
- D. Complete the panelboard schedule by accurately typing in a brief load description for the appropriate circuit number. Place a copy of the panelboard schedule in the pocket of the panelboard door.
- E. Each branch circuit conductor shall be clearly identified by color as to the phase connection. Wiring in panels shall be neat with rounded corners and tied in bundles with approved ties. See Section 16120.

- F. Where a common neutral is run for more than one branch circuit, the phase conductors shall be connected to separate, consecutive phases in order that the neutral will carry only the unbalanced current in each phase. Neutral conductors shall be same size as phase conductors unless specifically noted otherwise.
- G. Panelboards Mounted in distribution switchboards:
 - 1. Panelboards in distribution switchboards shall be installed by the switchboard manufacturer.

3.02 BALANCING

- A. Panelboard circuiting shall be as indicated on the Drawings whenever possible. Additional loads shall be placed to balance loads between phases as much as possible.

****END OF SECTION****

SECTION 16475

OVERCURRENT PROTECTIVE DEVICES

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Overcurrent Protective Devices such as fuses and circuit breakers.

1.02 SUBMITTALS

- A. Fuses: Submit catalog cuts which indicate the fuse symbol and ampere rating for each disconnect or device.
 - 1. Submit manufacturer's data showing fuse name, symbol, voltage rating, UL class, interrupting capacity or I-squared time (I^2t) characteristics and accessories.
 - 2. Fuse trip curves.
- B. Breakers: Submit catalog cuts that indicate type of breaker, size, trip, characteristics, interrupting capacity, and the specified features.

1.03 OPERATING AND MAINTENANCE MANUALS

- 1. Identify the size, model and features for each item.
- 2. Complete instructions regarding the operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
- 3. Refer to Specification Section 16010 for additional requirements.

1.04 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (see Section 16010):
 - 1. NFPA 70 (NEC)
 - 2. UL listing
 - 3. ANSI
 - 4. NEMA

1.05 RELATED WORK

- A. Division 16, Electrical

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Fuses:
 - 1. Bussmann Mfg. Div.
 - 2. Gould-Shawmut
 - 3. Little-Fuse

- B. Circuit Breakers:
 - 1. Schneider
 - 2. Eaton
 - 3. General Electric Co.

2.02 MATERIALS

- A. Fuses:
 - 1. Fuses up to 600 volts shall meet the following:
 - a. Be of the same manufacturer.
 - b. Shall NOT be shipped in fused switches.
 - c. Shall be stored in a safe, moisture free area until needed.
 - d. All dual element fuses shall have separate overload and short circuit elements. The overload element shall include a spring-assisted thermal unit. The thermal unit shall open on a temperature rise above 280 degrees Fahrenheit. Time delay for the overload element shall be at least 10 seconds at 500 percent of rated amperes.
 - e. When indicated on the Drawings or required by the local authority or serving utility, fuses shall be silver-sand UL Class R or Class L current-limiting fuses (low-peak dual element).
 - f. Motor branch circuit fuses rated 1/10 to 600 amperes shall be sized one ampere rating above the selected heater element. Fuse ampere rating shall not exceed 175 percent of motor FLA. Abnormal motor conditions requiring increased ampere ratings shall be referred to the Engineer. Fuses shall be UL Class R current-limiting dual element with time delay.
- B. Circuit Breakers:
 - 1. Low voltage breakers up to 600 volts shall meet the following:
 - a. Be quick-make, quick-break type.
 - b. Have toggle mechanism insuring full contact pressure until time of opening whether manually or automatically operated.
 - c. Thermal magnetic type to have inverse time tripping characteristics with fixed thermal trip action to hold on harmless momentary overload.
 - d. Adjustable trip setting shall be provided for all service entrance section main circuit breakers.
 - e. A short circuit condition shall cause the magnetic trip element to instantly trip without damage or injury.
 - f. Have non-welding, non-corroding contacts.
 - g. Be full-size with mechanism enclosed in molded bake-lite case, sealed to prevent tampering or unauthorized changes in calibration.

- h. Be UL listed and recognized.
- i. Meet NEMA standards.
- j. Be bolt-on type unless otherwise specified.
- k. Have contacts that operate in a multiple plate arc-quenching chamber vented to load side of breaker - UL listed.
- l. Be rated for AIC compatible with ratings of the panel or switchboard bus they are to be used in as indicated on the Drawings. Unless otherwise indicated, series rated devices are not acceptable. All overcurrent devices shall be fully rated.
- m. Be calibrated for operation in a minimum ambient temperature of 50 degree C.
- n. All multi-pole breakers shall have common trip.
- o. For multi-pole breakers shall require the same space as the equivalent number of single pole breakers. Wafer style breakers are unacceptable.
- p. Have operating handle that visually indicates “on”, “off”, or “tripped”.
- q. Be labeled to indicate circuit number(s) and load served.
- r. Be rated for 100% continuous operation where indicated on the Drawings.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Provide overcurrent protection for all wiring and equipment in accordance with NFPA 70, State or local codes, whichever is prevailing.
- B. Should nameplate data disagree with the size or application of an overcurrent protective device indicated on the Drawings, immediately bring it to the attention of the Engineer for a decision.
- C. Place a label inside each fused switch door. Label shall indicate fuse type, ampere rating and interrupting rating. Manufacturers’ labels are acceptable.
- D. Where blank spaces or spaces designated for future overcurrent devices are indicated on the Drawings, they shall be complete with bus links.

3.02 SPARE PARTS

- A. Furnish one spare set of three (3) of each size and type of fuse rated at more than 30 amperes, and 10 percent of each size and type of fuse rated 30 amperes or less, but in no case less than one set of three (3).

****END OF SECTION****

**SURGE PROTECTIVE DEVICE
(SPD)**

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section includes the Surge Protective Device (SPD) for the disinfection area service to provide protection of electrical equipment rated 600 volts and less from the harmful effects of surges, transients and electrical line noise and excessive voltages due to lightning strikes or switching transients.

1.02 SUBMITTALS

- A. Submit manufacturer's data demonstrating compliance with this Specification and the Drawings. Information shall include, but not be limited to:
1. Catalog data showing features and accessories in accordance with this specification.
 2. An equipment manual with installation, operation, and maintenance instructions for the specified unit.
 3. Electrical and mechanical drawings that show unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit.
 4. UL 1449 Third Edition compliance document showing the Voltage Protection Rating (VPR) for the specific catalog number(s) submitted.

1.03 OPERATING AND MAINTENANCE MANUALS

1. Identify the size, model and features for each item.
2. Complete instructions regarding the operation and maintenance of equipment involved. Instructions and documentation not related to the equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
3. Complete nomenclature of replaceable parts, part numbers, current cost, name and address of nearest vendor of replacement parts. Information on equipment or components not related to equipment furnished must be removed or crossed out. ***O&M manuals must be individually tailored to the project and equipment as furnished.***
4. Copy of warranties issued on the installation, showing dates of expiration.
5. Refer to Specification Section 16010 for additional requirements.

1.04 QUALITY ASSURANCE

- A. The SPD system shall be designed and manufactured to the following standards:
1. Underwriters Laboratory (UL) 1449-Third Edition
 2. Underwriters Laboratory (UL) 1283-Fifth Edition
 3. National Electric Code, 2011 (NEC)
 4. American National Standard Institute (ANSI)

5. Institute of Electrical and Electronic Engineers (IEEE)
 6. National Electrical Manufacturers Association (NEMA)
 7. National Fire Protection Association (NFPA)
 8. Occupational Safety and Health Act (including Pub. 81-123)
 9. Federal Information Processing Standards (FIPS)
- B. In addition, the system shall be tested in accordance with the following standards:
1. ANSI/IEEE C62.41, Categories A, B and C3 (10kA)
 2. ANSI/IEEE C62.45
- C. The SPD system shall be coordinated and engineered by the manufacturer. The system shall be manufactured in the USA by an ISO 9001 certified manufacturer engaged in the design and manufacture of SPD systems as specified for a minimum of five (5) years.

1.05 WARRANTY

- A. The SPD system manufacturer shall warranty the entire system against defective materials and workmanship for a period of **two years** following delivery from the manufacturer. This warranty is in effect as long as the unit is installed in compliance with the manufacturer's owner's/operator's manual, UL listing requirements, and any applicable national or local electrical codes.
- B. The manufacturer is required to have a nationwide network of factory-trained technicians dedicated to repair and service of this product. The manufacturer shall have a dedicated 1-800 telephone number for service problems and questions. This number must be manned 24 hours a day, 365 days a year by a knowledgeable factory employee to ensure prompt response to any emergency situation, which may arise. The manufacturer is required to be able to service the equipment on a local basis without the requirement to return the product to the manufacturer for proper repair.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. Small Service, Control Panel and Electrical Service Pedestal SPD's (SPD Cubes)
1. Emerson 420 Series
 2. Advanced Protection Technologies S50 Series
 3. Current Technology CGC Series
 4. Or equal

2.02 ENVIRONMENTAL REQUIREMENTS

- A. The SPD system shall be designed for operation in the following conditions:
1. Operating Temperature -40° F to 140° F
 2. Relative Humidity 0 - 95%

2.03 SMALL SERVICE, CONTROL PANEL & ELECTRICAL SERVICE PEDESTAL SPD ELECTRICAL REQUIREMENTS

- A. The SPD shall be ANSI/UL 1449 Third Edition, Type 2 listed with a minimum nominal discharge current rating of 20 kA and voltage rating as indicated on the Drawings.
- B. The Surge Current Capacity shall be 50 kA per mode and 100 kA per phase.
- C. The SPD shall provide protection in all modes: L-N, L-G, L-L, and N-G.
- D. The maximum UL 1449-Third Edition VPR ratings shall not exceed the following:

<u>Mode</u>	<u>120/240</u>	<u>120/208</u>	<u>277/480</u>
Line-Neutral	<u>700</u> VAC	<u>700</u> VAC	N/A
Line-Ground	<u>1000</u> VAC	<u>1000</u> VAC	<u>2000</u> VAC
Neutral-Gnd	<u>700</u> VAC	<u>700</u> VAC	N/A
Line-Line	<u>1200</u> VAC	<u>1200</u> VAC	<u>3000</u> VAC

- E. The unit shall be pre-wired with 36-inches of No. 10 AWG conductors.

2.04 ENCLOSURE

- A. The SPD cabinet enclosure shall be rated NEMA 4 for outdoor applications. The SPD shall be designed for wall mounting.

2.05 STANDARD MONITORING FEATURES

- A. Each protection module shall contain status lights to indicate whether the module is operating properly or when the module has failed. The normal operation of the protection module shall provide positive indication utilizing the green light.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. The SPD unit shall be wall-mounted where indicated on the Drawings per the manufacturer’s installation instructions.
- B. The SPD shall be installed as close as practical to the facility’s wiring system or equipment bus as indicated on the Drawings. The factory installed conductor shall be terminated to the overcurrent device without splicing additional cable or conductors.

****END OF SECTION ****

SECTION 16500

LIGHTING

PART 1 -- GENERAL

1.01 SUMMARY

- A. Section Includes: Luminaires and lamps.

1.02 SUBMITTALS

- A. Submit manufacturer's data for the following:
1. Luminaires with designation as indicated on the Drawings.
 2. Lamps (type, color, wattage, etc.).
 3. Light pole with accessories, including foundation details.
- B. Submit manufacturer's data demonstrating compliance with Specifications and the luminaires as indicated on the Drawings.

1.03 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards (see Section 16010):
1. UL listed and labeled.
 2. NEMA
 3. NFPA 70 (NEC)
 4. IES

PART 2 -- PRODUCTS

2.01 MATERIALS

- A. Luminaires shall be:
1. Furnished with proper hardware, mounting arm, etc.
 2. Furnished complete with gaskets and UL Listed for wet locations.
 3. Furnished complete with lamps with wattage and voltage as indicated on the Drawings.
 4. Furnished with specified finish and color.
- B. Lamps:
1. LED's and their driver shall be designed for minimum operational life of 50,000 hours in -20°C to 40°C ambient air temperature. The lumen output shall not decrease by more than 20% over the operational life. The driver shall decrease output power when the ambient air temperature is outside the -20°C - 40°C range instead of shutting the LED's off. The driver shall be UL listed and include a quick disconnect plug for maintenance. Kelvin temperature shall be 4000K unless otherwise indicated on the Drawings.
- C. Photocells:

1. Photocells shall operate on 120VAC unless otherwise indicated and housed in a heavy-duty, weatherproof housing.
 2. Normally open contacts shall close when ambient light falls to approximately 3-footcandles and open at approximately 12-footcandles.
- D. Light Poles:
1. Light poles shall be constructed of square aluminum tubing with a flush-mounted GFCI receptacle and light switch as indicated on the Drawings.
 2. Area light pole foundations must be designed for 80 mph wind loading with 100 mph wind gusts.

PART 3 -- EXECUTION

3.01 INTERFERENCES

- A. Contractor shall carefully examine the complete areas as well as each individual room where luminaires are to be installed, for interference with piping and other trades. Where such interferences occur, provide luminaires with proper type suspension to overcome such interferences.

3.02 INSTALLATION

- A. Augured holes with rebar cage installed shall be inspected by the Engineer prior to pouring concrete.
- B. Luminaires shall be installed parallel with walls and ground for a neat appearance. Where luminaires are indicated to be mounted on a perimeter wall, luminaires shall be installed on a flush mounted box at an elevation such that the top of fixture is flush with the top of wall.
- C. Operate luminaires after installation and connection. Check for proper operation. Replace luminaires that have failed or are not functional.

3.03 OPERATION

- A. Luminaires shall be controlled by a photocell and light switch located on the pole as indicated on the Drawings. The luminaire will operate from dusk-to-dawn using the photocell when the light switch is left in the ON position.

****END OF SECTION****

SUPPLEMENTAL SECTION 31 05 19

GEOGRID FOR EARTHWORK

PART 1: GENERAL

1.0 SUMMARY

- A. CONTRACTOR shall furnish all labor, materials, equipment and appurtenances necessary to provide a complete Mechanically Stabilized Earth (MSE) foundation improvement system having structural geogrids that interact with cohesionless soil to create a stiffened, high modulus raft foundation.
- B. Work consists of:
1. Furnishing structural geogrid reinforcement as specified herein and shown on the construction drawings.
 2. Storing, cutting and placing structural geogrid reinforcement as specified herein and as shown on the construction drawings.
 3. Placement and compaction of reinforced fill within the MSE foundation improvement system as specified herein and as shown on the construction drawings.
 4. Incidental earthwork as necessary to complete the MSE foundation improvement system specified herein and as shown on the construction drawings.

2.0 REFERENCES AND DEFINITIONS

- A. Where all or part of a Federal, ASTM, ANSI, AWWA, Arizona Uniform Standard Specification for Public Works Construction, etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.
- B. American Society for Testing and Materials (ASTM)
1. D698-12 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort
 2. D4972-01 (2007) – Standard Test Method for pH of Soils
- C. U.S. Environmental Protection Agency (U.S. EPA)
1. EPA 9090 - Compatibility Test for Wastes and Membrane Liners
- D. Related Work Specified Elsewhere:
1. General and Supplemental General Conditions of the Contract and Division 1.
 2. Section 01 33 00: Submittal Procedures

3. Section 31 20 00: Earthwork

E. Definitions:

1. Geogrid - A polymeric grid formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth and function primarily as reinforcement.
2. Multi-Layer Geogrid - A geogrid product consisting of multiple layers of grid which are not integrally connected throughout.
3. Resistance to Long-Term Degradation - Resistance to loss of load capacity or structural integrity when subjected to chemically aggressive environments measured via EPA 9090 immersion testing. Values shown are typical values.
4. Reinforced Fill - Compacted structural fill placed above and below the layers of geogrid, the reinforced fill boundaries shall be defined as the limits of the MSE foundation system as indicated on the construction drawings.

3.0 SUBMITTALS

- A. General: Submit listed submittals in accordance with conditions of the Contract and with Specification 01 33 00.
- B. Product Data: Submit product data sheets, including manufacturer's specifications, installation instructions, and general recommendations for installation.
 1. Include manufacturer's certification or other data substantiating that products comply with requirements of Contract Documents.
 2. Clearly identify product/model to be used.
- C. Certifications:
 1. Manufacturer's material certification in compliance with current ASTM Specifications.
 2. Manufacturer shall submit certification that the product meets the specifications herein.
- D. Shop drawings: Submit clear, concise drawing showing model number, size, arrangement and configuration of all products specified. Minimum sheet size is 8.5" X 11".
 1. Shall include working drawings, drawings showing profiles, accessories, location, and dimensions all necessary for installation.

PART 2: PRODUCTS

1.0 EQUIPMENT

- A. Structural Soil Reinforcement Geogrid – The geogrid component of the MSE foundation improvement system shall be integrally formed and produced from a punched sheet of

polypropylene which is then oriented in three substantially equilateral directions so that the resulting ribs shall have a high degree of molecular orientation, which continues at least in part through the mass of the integral node.

- B. The resulting geogrid structure shall have apertures that are triangular in shape, and shall have ribs with a depth-to-width ratio greater than 1.0.
- C. The properties contributing to the performance of Geogrid include the following, and compliance with specification shall be certified in writing by the manufacturer:

Index Properties	Longitudinal	Diagonal	Transverse	General
Rib pitch ⁽²⁾ , mm (in)	40 (1.60)	40 (1.60)	-	
Mid-rib depth ⁽²⁾ , mm (in)	-	1.8 (0.07)	1.5 (0.06)	
Mid-rib width ⁽²⁾ , mm (in)	-	1.1 (0.04)	1.3 (0.05)	
Nodal Thickness ⁽²⁾ , mm (in)				3.1 (0.12)
Rib shape				rectangular
Aperture shape				triangular

Structural Integrity	General
Junction efficiency ⁽²⁾ , %	93
Aperture stability, ⁽⁴⁾ kg-cm/deg @ 5.0kg-cm	3.6
Radial stiffness at low strain ⁽⁵⁾ , kN/m @ 0.5% strain (lb/ft @ 0.5% strain)	300 (20,580)

Durability	General
Resistance to chemical degradation ⁽⁶⁾	100%
Resistance to ultra-violet light and weathering ⁽⁷⁾	100%

- 1) Unless indicated otherwise, values shown are minimum average roll values determined in accordance with ASTM 4759-02. Brief descriptions of test procedures are given in the following notes.
- 2) Nominal dimensions.
- 3) Load transfer capability determined in accordance with GRI-GG2-87 and GRI-GG1-87 and expressed as a percentage of ultimate tensile strength.
- 4) In-plane torsional rigidity measured by applying a moment to the central junction of a 225mm x 225mm specimen restrained at its perimeter in accordance with U.S. Army Corps of Engineers Methodology for measurement of Torsional Rigidity, (Kinney, T.C. Aperture stability Modulus ref 3, 3.1.2000).
- 5) Radial stiffness is determined from tensile stiffness measured in any in-plane axis from testing in accordance with ASTM D6637-01.
- 6) Resistance to loss of load capacity or structural integrity when subjected to chemically aggressive environments in accordance with EPA 9090 immersion testing.
- 7) Resistance to loss of load capacity or structural integrity when subjected to 500 hours of ultraviolet light and aggressive weathering in accordance with ASTM D4355-05.

2.0 BACKFILL MATERIALS

A. See STS 31 20 00.

3.0 PRE-APPROVED MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work, include, but are not limited to, the following:

1. Tensar International Corporation, Inc. - TriAx™ TX160, or equal.

B. Substitutions/or equal: If alternative manufacturers other than the pre-approved manufacturer are proposed for any specified equipment in this section, the CONTRACTOR/bidder must supply a submittal; refer to STS 01 33 00.

PART 3: EXECUTION

1.0 CONTRACTOR'S RESPONSIBILITY

A. The CONTRACTOR is responsible for furnishing and installing the PRODUCT including all site preparation, and other items necessary for the proper installation and operation of the PRODUCT.

2.0 STORAGE AND HANDLING

A. The CONTRACTOR shall be responsible for the safe storage of the equipment until it is incorporated in the completed project.

B. Storage and Protection

1. Prevent excessive mud, wet concrete, epoxy, or other deleterious materials from coming in contact with and affixing to the geogrid materials.

2. Store at temperatures above -20 degrees F (-29 degrees C).

3. Rolled materials may be laid flat or stood on end.

3.0 EXAMINATION

A. The Contractor shall check the geogrid upon delivery to verify that the proper material has been received. The geogrid shall be inspected by the Contractor to be free of flaws or damage occurring during manufacturing, shipping, or handling.

4.0 INSTALLATION

A. FOUNDATION PREPARATION

1. Brush, trees, logs, topsoil, and other debris shall be removed as specified in the contract documents.

2. No fill shall be placed on frozen ground.
3. After clearing, grade smooth, compact, and establish the proper elevations as shown on the construction drawings or as directed by the Engineer.

B. STRUCTURAL GEOGRID INSTALLATION

1. Structural geogrid shall be laid at the proper elevation and alignment as shown on the construction drawings.
2. For square or rectangular footings, the structural geogrid shall be oriented such that the roll direction runs perpendicular to the roll direction of the previous layer of geogrid.
3. For strip footings, the structural geogrid shall be oriented such that the roll length runs parallel to the footing direction.
4. Geogrid may be temporarily secured in place with staples, pins, sand bags or backfill as required by fill properties, fill placement procedures or weather conditions.
5. Overlap
 - a) Structural geogrid sections shall be overlapped at minimum of three feet between adjacent separate geogrid sections.
 - b) Care shall be taken to ensure that structural geogrid sections do not separate at overlaps during construction. To prevent separation, simple joining methods may be utilized, such as wire ties, plastic ties, hog rings, staples or hooks. Joint spacing of 20 to 30 feet are normally adequate to prevent grid separation at overlaps.

C. GRANULAR FILL PLACEMENT OVER STRUCTURAL GEOGRID

1. The fill in the reinforced zone shall be placed in lift thickness as directed in STS 31 20 00. The fill in the reinforced zone shall be compacted to a density of at least 95 percent maximum density as determined by Standard Proctor Test (ASTM D698-98).
2. Granular fill material shall be placed, spread and compacted in such a manner that minimizes the development of wrinkles in the geogrid and/or movement of the geogrid.
3. A minimum loose fill thickness of 6 inches is required prior to operation of tracked vehicles over the geogrid. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid.
4. When integrally-formed geogrids are used, rubber-tired equipment may pass over the geogrid reinforcement at slow speeds (less than 10 mph).

5. When coated geogrids or geogrids composed of small-diameter fibers are used, rubber-tired equipment shall not be allowed directly on the geogrid. Sudden braking and sharp turning movements shall be avoided.

D. REPAIR

1. Any geogrid damaged during installation shall be replaced by the Contractor at no additional cost to the Owner.
2. Coated geogrids shall not be used if the coating is torn, shedding, cracked, punctured, flawed or cut, unless a repair procedure is carried out as approved by the Engineer. The repair procedure shall include placing a suitable patch over the defective area or applying a coating solution identical to the original coating.

E. PROTECTION

1. Follow the manufacturer's recommendations regarding protection from exposure to sunlight.

5.0 OPERATIONS AND MAINTENANCE MANUALS

- A. Not used

8.0 WARRANTY

- A. The PRODUCT and work shall be warranted against defects in material and workmanship for a period of one year. The warranty period shall begin after final inspection and acceptance by the project ENGINEER.

END OF SECTION

SUPPLEMENTAL SECTION 31 20 00

EARTHWORK

PART 1: GENERAL

1.0 SUMMARY

- A. Provisions of Division 01 shall govern work under this Section.
- B. This Section includes:
 - 1. Preparing sub grades for slabs-on-grade footings (foundation), walks, pavements, lawns and grasses and exterior plants.
 - 2. Excavating and backfilling for buildings and structures.
 - 3. Sub base course for concrete walks and pavements.
 - 4. Sub base course for asphalt paving.
- C. Related Sections:
 - 1. Std. Spec 201 "Site Clearing" for protection of existing trees indicated to remain, site clearing and grubbing, stripping and stockpiling topsoil, and removal of above-grade and below-grade improvements.
 - 2. Division 01 Section "Temporary Pollution Control" for temporary erosion and sedimentation control measures.
 - 3. Std. Spec 601 "Trench Excavation, Backfilling, and Compaction" for earthwork related to water and sewer utility trenches.
 - 4. Division 16 Electrical Sections for earthwork related to utility trenches.
 - 5. STS 01 21 19 for Testing and Quality Assurance procedures.
 - 6. STS 31 05 19 for Geogrid for Earthwork

2.0 REFERENCES AND DEFINITIONS

- A. Where all or part of a Federal, ASTM, ANSI, AWWA, and Arizona Uniform Standard Specification for Public Works Construction etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.
- B. DEFINITIONS:

1. Backfill: Soil material or controlled low-strength material used to fill an excavation.
2. Base Course: Course placed between sub-base course and hot-mix asphalt paving.
3. Bedding Course: Course placed over excavated sub-grade in a trench before laying pipe.
4. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
5. Choker Course: Course supporting slab-on-grade placed immediately below vapor retarder.
6. Excavation: Removal of material encountered above sub-grade elevations and to lines and dimensions indicated.
 - a) Unauthorized Excavation: Excavation below sub-grade elevations or beyond indicated lines and dimensions without direction by ENGINEER. Unauthorized excavation, as well as remedial work directed by ENGINEER, shall be without additional compensation.
7. Fill: Soil materials used to raise existing grades.
8. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
9. Sub-base Course: Course placed between sub-grade and base course for hot-mix asphalt pavement, or course placed between sub-grade and cement concrete pavement or cement concrete or hot-mix asphalt walk.
10. Sub-grade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below sub-base, drainage fill, or topsoil materials.
11. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.
12. Engineer Fill: Fill material that meets a specified gradation and moisture content and placed in specified lifts and to specified compaction.
13. Structural Fill: Imported fill material with greater load bearing features than in situ soils, providing the need bearing capacity for a structure and placed, in specified lifts, moisture and compaction, and at a specified thickness.

B. REFERENCES

1. American Society for Testing and Materials
 - a) ASTM D1556, Density of Soil in Place by the Sand-Cone Method

- b) ASTM D1557, Test for Moisture-Density Relations of Soils (Modified Proctor) using 10-lb hammer and 18-in Drop
- c) ASTM D2216, Laboratory Determination of Moisture Content of Soil.
- d) ASTM D2922, Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- e) ASTM D3017, Moisture Content of Soil a Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- f) ASTM D698, Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregates Mixtures Using 5.5 lbs (2.49 kg) Rammer and 12-inch (305 mm) Drop (also known as Standard Proctor Analysis)
- g) ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
- h) ASTM C150, Standard Specification for Portland Cement
- i) ASTM C 618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
- j) ASTM C 33, Standard Specification for Concrete Aggregates
- k) ASTM C 94/C 94M, Standard Specification for Ready-Mixed Concrete
- l) ASTM C 260, Standard Specification for Air-Entraining Admixtures for Concrete
- m) ASTM C 495, Standard Test Method for Compressive Strength of Lightweight Insulating Concrete

3.0 SUBMITTALS

- A. General: Submit listed submittals in accordance with conditions of the Contract and with Specification 01 33 00.
- B. Test Reports: Submit for acceptance, complete test reports from approved independent testing laboratories certifying that product conforms to performance characteristics and testing requirements specified herein.
- C. The contractor shall submit delivery slips of all Engineered Fill showing quantity and certifying compliance to mix specifications herein.

4.0 QUALITY ASSURANCE

- A. Testing Agency: OWNER will engage a qualified independent geotechnical engineering testing agency to perform field quality and control testing, see STS 01 21 19.

- B. Allow testing agency to inspect and test sub-grades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work show compliance with requirements.
- C. Engineered Fill/Structural Fill shall be testing for compliance, as suitable material, to these specifications. Testing shall be completed prior to use on project for each type of Engineered Fill/Structural Fill at the following frequencies:
 - 1. Tests completed:
 - a) One test completed for every 1,000 cubic yards of each type per WWTP site.
 - b) One test when fill changes source or visual change is observed.
 - c) As directed by Owner.
- D. Where fill or backfill is required to be compacted to a specified density. Tests will be performed at the following locations and frequencies:
 - 1. Paved and Structural Slab Areas: At sub-grade and at each compacted fill and backfill layer:
 - a) Two tests on different subgrade layers for each generator structure except the Kayenta Aeration Generator structure.
 - i. The Kayenta Aeration Generator structure shall have two tests for every 3 ft of engineered fill.
 - b) A compaction test of sub-grade shall be taken within 24 hours of pouring concrete.
 - c) Areas represented by non-complying test shall be reworked and re-tested for compliance.
 - d) Sub-grade testing may be consecutive with concrete cylinder tests.
 - 2. Foundation Wall Backfill: At each compacted backfill layer, at least 1 test for each 100 feet or less of wall length, but no fewer than 2 tests.
 - 3. Isolated Footing: 1 test under each footing.
 - 4. Non Structural Areas: Frequency of testing will be approximately one test for every 1,000 square feet and 2 feet of depth, unless otherwise directed by the Engineer.
- E. When testing agency reports that sub-grades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; re-compact and retest until specified compaction is obtained.

5.0 STORAGE AND HANDLING

- A. The CONTRACTOR shall be responsible for the safe storage of the equipment until it is incorporated in the completed project.

PART 2: PRODUCTS

1.0 MATERIALS

A. SOIL MATERIALS

- 1. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- 2. On-site soils are not recommended for use beneath foundations, slabs, or as backfill. The onsite clayey sand and lean clay may be blended with granular materials to meet the requirements of the engineered fill presented herein.

B. ENGINEERED FILL – LOW PERMEABILITY, NON-EXPANSIVE ENGINEERED FILL

- 1. Low permeability, non-expansive engineered fill materials shall be used as fill material for general site grading, floor slab areas, foundation areas and exterior slab areas.
- 2. Low permeability engineered, non-expansive fill soils should conform to the following:

<u>Gradation</u>	<u>Percent finer by weight (ASTM C136)</u>
1-inch	100
No. 4 Sieve.....	50-100
No. 200 Sieve.....	35 (max)
Liquid Limit	40 (max)
Plasticity Index	3 to 10
Maximum expansive potential (%)*	0.5

*Measured on a sample compacted to approximately 95 percent of the ASTM D698 maximum dry density at about 3 percent below optimum water content. The sample is confined under a 100 psf surcharge and submerged.

C. ORDINARY FILL

- 1. Excavated earth or sand thoroughly mixed to create uniform material.
- 2. Free of trash, debris, organic or frozen matter.
- 3. Largest rock or clod dimension: 3 inches.

D. CONTROLLED LOW-STRENGTH MATERIAL

1. Low-density, self-compacting, flowable concrete material as follows:
 - a) Portland Cement: ASTM C 150, Type I II or III.
 - b) Fly Ash: ASTM C 618, Class C or F.
 - c) Normal-Weight Aggregate: ASTM C 33, 3/8-inch nominal maximum aggregate size.
 - d) Water: ASTM C 94/C 94M.
 - e) Air-Entraining Admixture: ASTM C 260.
2. Compressive Strength: 500-psi when tested according to ASTM C 495.

PART 3: EXECUTION

1.0 CONTRACTOR'S RESPONSIBILITY

- A. The CONTRACTOR is responsible for furnishing and installing the PRODUCT including all site preparation, and other items necessary for the proper installation and operation of the PRODUCT.

2.0 EXAMINATION

- A. Examine all products for compliance with this section.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.0 PREPARATION

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by OWNER or others unless permitted in writing by ENGINEER and then only after arranging to provide temporary utility services according to requirements indicated in these Specifications.
 1. Notify ENGINEER not less than 2 days in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without ENGINEER'S written permission.
 3. Contact utility-locator service for area where Project is located before excavating.
- B. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

- C. Protect and maintain erosion and sedimentation controls during earthwork operations.
- D. Provide protective insulating materials to protect sub-grades and foundation soils against freezing temperatures or frost.

E. SITE PREPARATION

- 1. Clear and Grub per Std. Spec 201.
- 2. Exposed surfaces should be free of mounds and depressions which could prevent uniform compaction.
- 3. If unexpected fills or underground facilities are encountered during site clearing, such features should be removed and the excavation thoroughly cleaned prior to backfill placement and/or construction.

F. EXCAVATION, GENERAL

- 1. Excavate to sub-grade elevations regardless of the character of surface and subsurface conditions encountered. Excavated materials may include rock, soil materials, and obstructions. No changes in Contract Sum or Contract Time will be authorized for rock excavation or removal of obstructions.
 - a) If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

- 2. Explosives: Do not use explosives.

G. EXCAVATION FOR STRUCTURES

- 1. Excavation beneath structure is intended to remove existing loose/soft soils or fill.
- 2. Unless otherwise indicated in the plans, the existing soils beneath the new structures shall be removed to a minimum depth of three feet below the bottom of foundation elevation.
- 3. Excavate to within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - a) Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing engineered fill. Trim bottoms to required lines and grades to leave solid base to receive other work.
- 4. The Engineer shall observe the excavation prior to back fill placement.

H. EXCAVATION FOR WALKS AND PAVEMENTS

1. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and sub-grades.

I. EXCAVATION BACKFILL AND COMPACTION FOR UTILITY TRENCHES

1. See Std. Spec 601.

J. SUBGRADE INSPECTION

1. Notify ENGINEER when excavations have reached required subgrade.
2. If ENGINEER determines unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
3. Proof-roll sub-grade below building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated sub-grades.
 - a) Completely proof-roll sub-grade in one direction, repeating proof-rolling in direction perpendicular to first direction.
 - b) Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by ENGINEER, and replace with compacted backfill or fill as directed by the ENGINEER.
4. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
5. Reconstruct sub-grades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by ENGINEER, without additional compensation.

K. UNAUTHORIZED EXCAVATION

1. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Controlled low strength material with 28-day compressive strength of 500 psi may be used when approved by ENGINEER.
 - a) Fill unauthorized excavations under other construction or utility pipe as directed by ENGINEER.

L. STORAGE OF SOIL MATERIALS

1. Stockpile borrow-soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

- a) Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

M. SUBGRADE PREPARATION

1. The subgrade shall be compacted as specified herein.
2. A reinforcing geogrid shall be placed on the compacted surface and three feet of compacted engineered fill shall be placed on the geogrid. The reinforcing geogrid shall be furnished and installed as specified in STS 31 05 19.
3. The engineered fill materials underlain by a reinforcing geogrid should extend laterally at least two (2) feet beyond the foundation plus a distance of eight (8) inches for each additional foot of excavation beyond the three (3) feet minimum.
4. Areas of loose soils may be encountered at foundation bearing depth after excavation is completed for footings. When such conditions exist beneath planned foundation or floor slab areas, the surface of the subgrade soils should be moisture conditioned and compacted as specified herein prior to placement of the required depth of engineered fill.
5. If sufficient compaction cannot be achieved in-place, the loose soils should be removed and replaced as engineered fill material or other approved materials.
6. For placement of fill below footings and floor slabs, the excavation should be widened laterally, at least eight inches for each foot of fill placed below footing base elevations.

N. BACKFILL

1. Place and compact backfill in excavations promptly, but not before completing the following:
 - a) Construction below finish grade including, where applicable, damp proofing, waterproofing, and perimeter insulation.
 - b) Surveying locations of underground utilities for Record Documents.
 - c) Testing and inspecting underground utilities.
 - d) Removing concrete formwork.
 - e) Removing trash and debris.
 - f) Removing temporary shoring and bracing, and sheeting.
 - g) Installing permanent or temporary horizontal bracing on horizontally supported walls.

2. The clean clay materials encountered in the area shall be used as compacted fill in the top 12 inches around the perimeter of the structures.
 - a) This "clay cap" will tend to act as a moisture barrier to help deter surface water from infiltrating into the subsurface soils.
 - b) The "clay cap" shall extend for a minimum distance of 10 feet from foundation perimeters.
3. Place fill, including back-fill, and sub-base, on sub-grades free of mud, frost, snow, or ice.
4. Backfill beneath and around structures shall be engineered fill as specified herein.
5. Unless otherwise shown in plans, non-structural fill shall use ordinary fill as specified herein.

O. SOIL MOISTURE CONTROL

1. Uniformly moisten or aerate sub-grade and each subsequent fill or backfill soil layer before compaction to within -1 to 3% (see table below) of optimum moisture content.
 - a) Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by -1 to 3% (see table below) percent and is too wet to compact to specified dry unit weight.

P. COMPACTION OF BACKFILLS AND FILLS

1. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
2. Place backfill and fill soil materials evenly on sides of structures to required elevations, and uniformly along the full length of each structure.
3. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698 (see table below):
 - a) Under structures, building slabs, steps, and pavements, scarify and re-compact top 12 inches of existing sub-grade and each layer of backfill or fill soil material at 95 percent as shown in the table below.

Material Type and Location	Per the Standard Proctor Test (ASTM D 698)		
	Minimum Compaction Requirement (%)	Range of Moisture Contents for Compaction	
		Minimum	Maximum
Approved on-site clayey sand/granular blend or approved imported fill soils:			
Beneath foundations and floor slabs:	95	-1%	+3%
Beneath exterior slabs:	95	-1%	+3%
Miscellaneous backfill:	95	-1%	+3%

- b) Non-structural areas, unless otherwise shown in the plans, using ordinary fill, shall be compacted to 85% minimum.

Q. GRADING

1. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 - a) Provide a smooth transition between adjacent existing grades and new grades.
 - b) Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
2. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish sub-grades to required elevations within the following tolerances:
 - a) Lawn or Unpaved Areas: Plus or minus 1 inch.
 - b) Walks: Plus or minus 1 inch.
 - c) Pavements: Plus or minus 1/2 inch.
3. Final surrounding grades shall be sloped away from the structures on all sides to prevent ponding of water as shown on the plans.
4. Exposed ground shall be sloped at a minimum 3 percent away from the foundation areas for at least 10 feet beyond the perimeter of the foundation.

R. SUBBASE COURSES

1. On prepared sub-grade, place sub-base course under pavements and walks as follows:
 - a) Shape sub-base course to required crown elevations and cross-slope grades.

- b) Place sub-base course 6 inches or less in compacted thickness in a single layer.
 - c) Place sub-base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 - d) Compact sub-base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.
2. Pavement Shoulders: Place shoulders along edges of sub-base and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each sub-base and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

S. FLOOR SLAB

1. Floor slabs shall be constructed as specified below:

DESCRIPTION	VALUE
Interior floor system	Slab-on-grade concrete.
Subbase	4 inches of aggregate base course materials.
Floor slab support	Minimum 36 inches of approved low permeability engineered fill (granular, non-expansive engineered fill for the aeration/digestion tank) placed on approved geogrid, placed and compacted in accordance with Earthwork section of this report.

- 2.

T. PROTECTION

- 1. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- 2. Repair and reestablish grades to tolerances specified to where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
- 3. Where settling occurs before project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - a) Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

U. DISPOSAL OF SURPLUS AND WASTE MATERIALS

- 1. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off OWNER'S property unless otherwise noted in plans.

4.0 WARRANTY

- A. The PRODUCT and work shall be warranted against defects in material and workmanship for a period of one year. The warranty period shall begin after final inspection and acceptance by the project ENGINEER.

END OF SECTION

SUPPLEMENTAL SECTION 31 55 00

EARTH RETENTION

PART 1: GENERAL

1.0 SUMMARY

- A. Include materials, labor services and incidentals necessary for the completion of this section of the work.
- B. Work generally includes design and installation of a "sheet-pile," "soil-nailed" or "soldier pile and lagging" earth retention system to retain the deep excavations, with slopes greater than 1:1.
- C. This CONTRACTOR assumes responsibility for damage due to placement or movement of the retention system until walls and structures are in place, up to grade and backfilling is complete.
- D. The work of this section will be subject to monitoring as described in Section 31 20 00.

2.0 REFERENCES AND DEFINITIONS

- A. Where all or part of a Federal, ASTM, ANSI, AWWA, and Arizona Uniform Standard Specification for Public Works Construction etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.

3.0 SUBMITTALS

- A. General: Submit listed submittals in accordance with conditions of the Contract and with Specification 01 33 00.
- B. Product Data: Submit product data, including manufacturer's specifications, installation instructions, and general recommendations for installation. Also include manufacturer's certification or other data substantiating that products comply with requirements of Contract Documents. Clearly identify product/model to be used.
- C. Test Reports: Submit for acceptance, complete test reports from approved independent testing laboratories certifying that product conforms to performance characteristics and testing requirements specified herein.
- D. Shop drawings: Submit clear, concise drawing showing model number, size, arrangement and configuration of all products specified. Minimum sheet size is 8.5" X 11".

4.0 STORAGE AND HANDLING

- A. The CONTRACTOR shall be responsible for the safe storage of the equipment until it is incorporated in the completed project.

PART 2: PRODUCTS

1.0 SPECIFICATIONS

- A. The Earth Retention system shall be designed by a qualified Geotechnical ENGINEER experienced in the design of this type of system and registered as a Professional ENGINEER in the State of Arizona.
- B. See drawings for loading of adjacent structures or equipment which may impact retention system design.
- C. The Retention system, shall allow no more than 1.0" lateral movement and no more than 1/8" of settlement of the adjacent structures. The Earth Retention designer shall also establish field testing requirements for materials used.
- D. An alternate system to 'soil-nailing' maybe used if shown to be adequate by calculation and upon approval by the A/E.

2.0 MATERIALS

- A. Products/materials to be used shall be specified by the Earth Retention Designer.

3.0 PRE-APPROVED MANUFACTURERS

This section not used.

PART 3: EXECUTION

1.0 CONTRACTOR'S RESPONSIBILITY

- A. The CONTRACTOR is responsible for furnishing and installing the PRODUCT including all site preparation, and other items necessary for the proper installation and operation of the PRODUCT.

2.0 EXAMINATION

- A. Examine all products for compliance with this section.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.0 PREPARATION & INSTALLATION

- A. Perform work in strict compliance with the design and specifications provided by the Earth Retention System Designer and as approved by the A/E.
|
- B. Coordinate work with both the Earthwork CONTRACTOR and the Underpinning CONTRACTOR
- C. Specified Note: Edit as required.

- D. For cold weather construction, provision shall be made to follow the requirements ACI 306 "Requirements for Cold Weather Concreting."
- E. Remove "soil nails" or tie-backs within 4 feet of finish grade, or deeper as required by local utility easements. Removal may be completed after first floor is poured and cured.
- F. No shotcrete shall be placed against frozen excavation faces. Exposed excavation faces shall be protected or heated as required by ACI 306.

4.0 OPERATIONS AND MAINTENANCE MANUALS

This section is not used.

5.0 WARRANTY

- A. The PRODUCT and work shall be warranted against defects in material and workmanship for a period of one year. The warranty period shall begin after final inspection and acceptance by the project ENGINEER.

END OF SECTION

SUPPLEMENTAL SECTION 33 31 15

LARGE DIAMETER POLYVINYL CHLORIDE (PVC) GRAVITY SEWER PIPE

PART 1: GENERAL

1.0 SUMMARY

- A. Furnish and install large diameter (greater than 15") plastic sewer pipe and fittings for non-pressure flow as shown on the plan set. All work shall be done in strict accordance with the drawings and related specifications (supplemental and standard) and the manufacture recommendations.
- B. It is the intent of these specifications and shall be the responsibility of the CONTRACTOR to take whatever measures shall be deemed necessary to insure that this requirement shall have been met.
- C. The equipment specified herein shall distribute raw, partially treated, and treated municipal wastewater and municipal wastewater sludge.

2.0 REFERENCES AND DEFINITIONS

- A. Where all or part of a Federal, ASTM, ANSI, AWWA, and Arizona Uniform Standard Specification for Public Works Construction etc. is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.
- B. Related Work Specified Elsewhere:
 - 1. General and Supplemental General Conditions of the Contract and Division 1.
 - 2. Section 01 33 00: Submittal Procedures
 - 3. Section 615 – Sewer Line Construction
 - 4. Section 601 – Trenchlines, Backfilling and Compaction.
 - 5. Section 625 – Manhole Construction and Drop Sewer Connections
 - 6. Section 745 – [Small Diameter] PVC Sewer Pipe and Fittings
- C. American Society for Testing Materials (ASTM)
 - 1. ASTM D1598 – Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
 - 2. ASTM D1599 – Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing and Fittings
 - 3. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

4. ASTM D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
5. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
6. ASTM F679 - Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
7. ASTM F758 - Standard Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport and Similar Drainage.
8. ASTM F789 - Standard Specification of Type PS-46 and Type PS-115 Poly (Vinyl Chloride) (PVC) Plastic Gravity Flow Sewer Pipe and Fittings.
9. ASTM F794 - Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
10. ASTM F1760 – Standard Specification for Co-extruded Poly (Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content.
11. ASTM F1803 - Standard Specification for Poly (Vinyl Chloride) (PVC) Closed Profile Gravity Pipe and Fittings Based on Controlled Inside Diameter.
12. ASTM D1784 – Specifications for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
13. ASTM D2412 – Test Method for determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
14. ASTM D3034 – Specification for type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
15. ASTM F679 – Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
16. ASTM F794 – Specification for Poly (Vinyl Chloride) (PVC) Large Diameter Ribbed Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.

D. National Sanitation Foundation (NSF)

1. Standard No. 14 - Plastic Piping Components and Related Materials.

E. Uni-Bell PVC Pipe Association (Uni-Bell)

1. Uni-Bell Handbook for PVC Pipe Design and Construction.
2. UNI-B-6 – Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe.

F. DEFINITIONS:

1. Buried Pipe: Pipe that is buried in the soil, or cast in a concrete pipe encasement that is buried in the soil.
2. Exposed Pipe: Pipe that is located above ground, or pipe that is located inside a structure, supported by a structure, or case into a concrete structure.
3. Underground Piping: Piping actually buried in soil or cast in concrete.
4. Underwater Piping: Piping below tops of walls in basins or tanks containing water.

3.0 SUBMITTALS

- B. General: Submit listed submittals in accordance with conditions of the Contract and with Specification 01 33 00.
- C. Product Data: Submit product data, including manufacturer's specifications, installation instructions, and general recommendations for installation. Also include manufacturer's certification or other data substantiating that products comply with requirements of Contract Documents. Clearly identify product/model to be used.
- D. Test Reports: Submit for acceptance, complete test reports from approved independent testing laboratories certifying that product conforms to performance characteristics and testing requirements specified herein.
- E. Shop drawings: Submit clear, concise drawing showing model number, size, arrangement and configuration of all products specified. Minimum sheet size is 8.5" X 11".

4.0 QUALITY ASSURANCE

- A. All materials shall be tested in accordance with the applicable Federal, State, or ASTM Specification and the basis for rejection shall be as specified therein. Certified copies of the tests shall be submitted with each shipment of material.
 1. PVC Pipe and Fittings
 - a) Test: ASTM D3034, ASTM F1760 or ASTM F786 as applicable
- B. The CONTRACTOR shall submit certification from the manufacturer of the pipe as specified in Specification 01 33 00 as to the pipe material and that the pipe meets or exceeds the required testing. Only pipe manufactured in the United States of America will be acceptable.
- C. All materials will be subject to inspection and approved by the Project ENGINEER or the OWNER'S REPRESENTATIVE after delivery and no broken, cracked, misshapen, imperfectly coated, or otherwise damaged or unsatisfactory material shall be used.
- D. All pipes, fittings, and appurtenances shall be new. Fittings, pipes, and appurtenances of the same type shall be supplied by the same manufacturer.

- E. All material found during the progress of the work to have cracks, flaws, or other defects shall be rejected and promptly removed from the site.
- F. All pipe and fittings shall be the products of a single manufacturer.

5.0 STORAGE AND HANDLING

- A. The CONTRACTOR shall be responsible for the safe storage of the equipment until it is incorporated in the completed project.
- B. Store PVC pipe under cover to protect from ultraviolet light.
- C. Carefully examine each pipe and fitting for cracks and other defects while suspended above the trench immediately before installation.
- D. The CONTRACTOR shall be responsible for the safe storage of the equipment until it is incorporated in the completed project. If damage occurs to any pipe, fittings, valves, or other accessories in handling, the damage shall be immediately brought to the ENGINEERS's attention.
- E. Under no circumstances shall any pipe or appurtenances be dropped.
- F. PIPE STORAGE: All types of plastic pipe shall be stored in a manner that the pipe will not be deformed as recommended by the manufacturer. PVC pipe is subject to potential degradation when exposed to prolonged periods of sunlight. Material degradation is generally indicated by a discoloration of the pipe. PVC pipe shall be stored inside a building, under a cover or covered up totally. All discolored pipe shall not be installed and shall immediately be removed from the project.

PART 2: PRODUCTS

1.0 SPECIFICATIONS

- A. POSITIVE IDENTIFICATION: All PVC pipe shall be coded in accordance with the applicable material standard to eliminate future confusion and prevent accidental damage and service interruption of the facilities. PVC pipe used for sanitary sewer collection lines shall be green in color.
- B. LINE LOCATOR: Metallic tape shall be used as a locator for all plastic pipes which is installed less than 10 feet deep. The tape should be installed 2 ft. to 6 ft. below top of ground and centered over the pipe. When feasible, the tape shall be fastened to metallic appurtenances associated with the installation (i.e. valves, fittings, manhole rings, etc.) in an effort to enhance its detectability.
- C. All plastic pipe which is connected to a manhole, junction box, inlet or similar structure shall be installed with an approved manhole connection adaptor or water-stop as shown in the drawings such that each connection is leak-free and that there is no detrimental affect resulting from the material property characteristic differences between the plastic pipe and the structure.
- D. BELL AND SPIGOT JOINTS: Pipe with gasket joints shall be manufactured with a socket configuration, which will prevent improper installation of the gasket and ensure that the gasket shall remain in

place during joining operations. The gasket shall be manufactured from a synthetic elastomer material and shall conform to the requirements of ASTM F477. The spigot end of each joint of pipe shall be marked circumferentially to indicate the proper home mark. Pipe, which is field-cut, shall be chamfered and the home mark identified in accordance with the applicable criteria.

- E. Fittings and couplings shall be as specified herein.
- F. See Specification 630 for requirements for Gate, Butterfly and Pressure Reducing Valves.
- G. All exposed valves to have flange connections except where otherwise indicated on the drawings.
- H. See Specification 601 for requirements for trenching, backfill, and compaction.

2.0 MATERIALS

A. Polyvinyl Chloride (PVC) Gravity Flow Pipe:

1. The material in PVC pipe shall be in accordance with ASTM D1784.
2. Lateral line connections shall be made at manholes or at factory manufactured saddles or tees only, unless specifically authorized by the ENGINEER.
3. Small diameter PVC gravity flow pipe in sizes 4-inches through 15-inches shall meet the requirements of ASTM D 3034; see Section 745. Only solid wall pipe shall be used. Minimum wall classification shall be SDR 35.
4. PVC gravity glow pipe in sizes 18-inch and larger shall meet the requirements of ASTM F 679 or ASTM F 794. Minimum pipe stiffness shall be 46 psi.

3.0 PRE-APPROVED MANUFACTURERS

- A. This section not used.

PART 3: EXECUTION

1.0 CONTRACTOR'S RESPONSIBILITY

- A. The CONTRACTOR is responsible for furnishing and installing the PRODUCT including all site preparation, and other items necessary for the proper installation and operation of the PRODUCT.

2.0 EXAMINATION

- A. Examine all products for compliance with this section.
- B. Proceed with installation only after unsatisfactory conditions have been corrected

3.0 PREPARATION

- A. Establish line and grade for pipe and appurtenances. Verify location and elevation of existing manholes for collector sewer which are to be connected to new interceptors.
- B. Examine trench foundation for stability. Do not install material until defects have been corrected.
- C. Clean pipe and fittings of foreign matter and inspect for damage immediately prior to lowering into trench. Do not install damaged or defective pieces.

4.0 INSTALLATION

A. TRENCHING

- 1. Install pipe in trench prepared as specified in Standard Specification 601.
- 2. When laying PVC pipe, a metalized detectable warning tape shall be installed a minimum of 1 foot above the top of pipe and 3 to 6 feet below the final surface. The tape shall be detectable with a standard metal pipe locator. The color of tape shall be safety precaution blue and will be inscribed at 10-foot intervals with the words, "CAUTION BURIED WATER (SEWER) LINE BELOW," as applicable. Tape shall be 2 inches wide. The tape shall be constructed of material that is impervious to alkalis, acids, chemical reagents, and solvents found in the soils.
- 3. The trench shall be dry when the fine grading of the bottom of the trench is accomplished. Before placement of pipe the fine grade shall be carefully checked by use of a string line, laser beam, or other means so that when in final position the pipe will be true to line and grade, ± 0 1/16-inch per foot of length. If a piece of pipe fails to meet this requirement check for straightness, it shall be rejected and removed from the site. Laying instructions of the manufacturer shall be explicitly followed.

B. LAYING PIPE

- 1. Pipe shall be of the type, class, and size called for on the plans.
- 2. All pipes shall be protected during handling against impact shocks and free falls. No damaged or defective pipe shall be installed in the work. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a pipe in a satisfactory manner at no additional cost to the OWNER.
- 3. All pipe and fittings shall be thoroughly cleaned before installation. Pipe shall be kept clean at all times, and as the work progresses, the interior of the pipe shall be cleared of all dirt and superfluous materials of every description. The laying of the pipe shall be in finished trenches free from water or debris, and shall be commenced at the lowest point, with the spigot ends pointing in the direction of the flow. Each pipe shall be laid firmly and true to line and grade, in such manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets of the flowline. Any adjustment to line and grade shall be made by scraping away or filling in under the body of the pipe, never by wedging or blocking under the pipe ends.

4. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be used with a bell shall be beveled to conform to the manufactured spigot end.
5. The alignment and grade of each length of pipe shall be checked after setting by measurement from the string line, laser beam target or other means approved by the ENGINEER. At all times when work is not in progress, open ends of the pipe and fittings shall be securely closed to the satisfaction of the ENGINEER, so that no water, earth or other substance will enter the pipe or fittings. PVC pipe and fittings shall be installed in accordance with ASTM D-2321.
6. The PVC pipe bedding shall be placed in two lifts. The first lift will be from the bottom of the trench to the spring line of the pipe. The second lift will be from the spring line to one foot above the top of pipe. Separate inspections will be required on each lift. The CONTRACTOR shall place the first lift in a manner that will insure uniform support under the haunches and proper alignment of the pipe.

C. SEPARATION

1. To protect water lines from contamination by sewer lines, separation and extra protection shall be in accordance with drawings. Sewer lines that are constructed of ductile iron pipe for extra protection shall be internally lined for sewer service.

D. FITTINGS

1. All fittings shall conform to the requirements of the pipe specifications and shall be located as shown on the plans, or as directed by the ENGINEER, in accordance with the standard details.

E. JOINTINGS

1. Rubber Gasket Joints: Prior to making pipe joints, all surfaces of the portions of the pipes to be joined shall be cleaned, dried, and prepared in accordance with the manufacturer's recommendations. The joints shall then be carefully centered and completed.
2. Trenches shall be kept water-free during the installation of joints and couplings.
3. The joint and coupling materials will be as specified in the appropriate pipe sections and shall be installed in accordance with the manufacturer's recommendations. Cement mortar joints will NOT be permitted in sanitary sewer construction.
4. Water Stops: Water stops will be required when connecting PVC or HDPE pipe to concrete structures, manholes, etc. The water stop shall comply with Section 738 and will be installed per manufacturer recommendations.

F. MANHOLES:

1. Manholes shall be constructed to conform to the requirements of Sections 625, Section 505 and standard details.

G. BACKFILLING:

1. Backfilling and compaction shall be done in accordance with Sections 601.

H. TESTING:

1. Furnish all necessary equipment and labor for carrying out the specified tests.
2. Sewers and pipe lines shall be subject to acceptance testing after backfilling has been completed but prior to the placement of the finished surface material.
3. Low-Pressure Air Testing: Testing will be accomplished by the means of "Low Pressure Air Testing." Tests may be conducted by the CONTRACTOR or an independent testing firm. However, acceptance tests shall be made only in the presence of the ENGINEER. Follow testing procedure in Section 615.
4. Exfiltration Testing: Sanitary sewer testing by means of exfiltration should only be considered when low pressure air testing cannot be used and only with the approval of the ENGINEER. Follow testing procedure in Section 615.
5. Infiltration Testing:
6. Allowable Deflection Test: In addition to the tests prescribed above, the CONTRACTOR shall perform a deflection test on the system as directed by the ENGINEER. Any part of the installation which shows deflection in excess of 5% of the average inside diameter per ASTM D-3034 for PVC pipe, shall be corrected. After acceptance but prior to the termination of the warranty period, the OWNER may test the long term deflection of the sewer. If the Contracting Agency determines that the deflection has exceeded 7 ½% of the average inside diameter, that portion of the installation shall be corrected by the CONTRACTOR at no cost to the OWNER. Deflection shall be measured with a rigid mandrel (Go/No Go) device cylindrical in shape and constructed with a minimum of nine evenly spaced arms or prongs. Drawings of the mandrel with complete dimensions shall be submitted to the ENGINEER for each diameter of pipe to be tested. The mandrel shall be hand pulled through all sewer lines. Any section of sewer not passing the mandrel shall be uncovered at no additional cost to the OWNER and the bedding and backfill replaced to prevent excessive deflection. Repaired pipe shall be retested at no additional cost to the OWNER. Retested pipe shall not deflect more than 4 percent.
7. Closed Circuit T.V. Inspection: The OWNER reserves the right to visually inspect the interior of the sewer line using a television camera. Any defects in the pipe or construction methods revealed shall be corrected by the CONTRACTOR at no additional cost to the OWNER. The OWNER will pay for the initial T.V. inspection. Any additional inspection(s) required, due to the failure of the initial inspection, shall be paid for by the CONTRACTOR.

I. PAVEMENT AND SURFACING REPLACEMENT

1. Pavement and surfacing replacement shall be done in accordance with Section 336.

J. CLEANUP:

1. The ENGINEER has the right to close down forward trenching and pipe laying where testing, backfill, compaction and cleanup does not follow in an orderly manner

- K. No pipe shall be installed in water or when it is the ENGINEER's opinion that the trench is unsuitable.

5.0 OPERATIONS AND MAINTENANCE MANUALS

- A. This section not used

6.0 WARRANTY

- A. The manufacturer shall warranty materials for a minimum of 5 years after installation.

END OF SECTION

SUPPLEMENTAL SECTION 35 20 16.26

HYDRAULIC SLUICE GATE

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. **SCOPE.** This section covers Stainless Steel Flow Control Sluice Gates and operators.
- B. **GENERAL:**
 - 1. The equipment provided under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer unless exceptions are noted by the engineer.
 - 2. Gates and operators shall be supplied with all the necessary parts and accessories indicated on the drawings, specified or otherwise required for a complete, properly operating installation, and shall be the latest standard product of a manufacturer regularly engaged in the production of fabricated gates.

1.2 RELATED SECTIONS

- A. General and Supplemental Conditions of the Contract and Division 1.
- B. STS 01 33 00: Submittal Procedures.

1.3 REFERENCES

- A. AWWA: C561 - Fabricated Stainless Steel Slide Gates
- B. ISO 9001: 2000 - Quality management systems
- C. ASME: Section IX - Welding & brazing Qualification
- D. Related Work Specified Elsewhere:
 - 1. General and Supplemental General Conditions of the Contract and Division 1.
 - 2. Section 01 33 00: Submittal Procedures

1.4 PERFORMANCE REQUIREMENTS

- A. **LEAKAGE.** Sluice gates shall be substantially watertight under the design head conditions. Under the design seating head, the leakage shall not exceed 0.05 U.S. gallons per minute per foot (0.60 l/min per meter) of seating perimeter. Under the design unseating head, the leakage for heads of 20 feet (6m) or less shall not exceed 0.1 U.S. gallon per minute per foot (1.25 l/min per meter) of perimeter.
- B. **DESIGN HEAD:** The sluice gates shall be designed to withstand the design head shown in the schedule.

- C. **SEAL PERFORMANCE TEST:** The gate's sealing system should have been tested through a cycle test in an abrasive environment and should show that the leakage requirements are still obtained after 25,000 cycles with a minimum deterioration.

1.5 SUBMITTALS

- A. General: Submit listed submittals in accordance with conditions of the Contract and with Specification 01 33 00.
- B. Product Data: Submit product data sheets, including manufacturer's specifications, installation instructions, and general recommendations for installation.
 - 1. Include manufacturer's certification or other data substantiating that products comply with requirements of Contract Documents.
 - 2. Clearly identify product/model to be used.
- C. Certifications:
 - 1. Manufacturer's material certification in compliance with current ASTM Specifications.
 - 2. Manufacturer shall submit certification that the product meets the specifications herein.
- D. Shop drawings: Submit clear, concise drawing showing model number, size, arrangement and configuration of all products specified. Minimum sheet size is 8.5" X 11".
 - 1. Shall include working drawings, drawings showing profiles, accessories, location, and dimensions all necessary for installation.

1.6 QUALITY ASSURANCE

- A. Qualifications: Manufacturers shall have a minimum of 5 years full time experience producing work of similar scope and complexity and shall show evidence of satisfactory operation in at least 50 installations. The manufacturer's shop welds, welding procedures and welders shall be qualified and certified in accordance with the requirement of the latest edition of ASME, Section IX. Refer to Section 01 45 00 – Quality Control.
- B. Regulatory Requirements: This section not used.
- C. Certifications: Installer shall be certified by the manufacturer to meet or exceed the minimum requirements specified herein. The manufacturer shall be ISO 9001: 2000 certified.
- D. Field Samples: This section not used.
- E. Mock-Ups: This section not used.
- F. Pre-Installation: This section not used.
- G. Gates shall be shop inspected for proper operation before shipping.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Gates and appurtenances shall be handled and installed in accordance with the manufacturer's recommendations.

1.8 PROJECT CONDITIONS

- A. Environmental Requirements: Comply with environmental requirements and recommendations of manufacturer for proper installation of products.
- B. Field Measurements and Conditions: In addition to provisions of the Conditions of the Contract, verify dimensions and obtain field measurements prior to producing shop drawings and ordering products. Verify field conditions and condition of substrate and adjoining Work before proceeding with Work specified in this Section.

1.9 SEQUENCING AND SCHEDULING

- A. Sequencing and Scheduling. General: Refer to sequence requirements specified in Section 01 11 00 – Summary of work and construction progress schedule requirements specified in Section 01 33 00 – Submittals Procedures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work, include, but are not limited to, the following:
 - 1. Fontaine
- B. Substitutions: If alternative manufacturers other than the pre-approved manufacturer are proposed for any specified equipment in this section, the CONTRACTOR/bidder must supply a submittal, refer to STS 01 33 00 for requirements after the effective date of the agreement.

2.2 PRODUCT

A. SLUICE GATES

- 1. **GENERAL DESIGN.** Gates shall be self-contained of the rising stem configuration.
- 2. **FRAME.** The gate frame shall be constructed of structural members or formed plate welded to form a rigid one-piece frame. The frame shall be of the flange back design suitable for mounting on a concrete wall (CW). The guide slot shall be made of UHMWPE (ultra high molecular weight polyethylene).

The frame configuration shall be of the standard-bottom type and shall allow the replacement of the top and side seals without removing the gate frame from the concrete.
- 3. **SLIDE.** The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to 1/720 of the gate's span under the design head.
- 4. **GUIDES AND SEALS.** The guides shall be made of UHMWPE (ultra high molecular weight polyethylene) and shall be of such length as to retain and support at least two thirds (2/3) of the vertical height of the slide in the fully open position.

Side and top seals shall be made of UHMWPE (ultra high molecular weight polyethylene) of the self-adjusting type. A continuous compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The

sealing system shall maintain efficient sealing in any position of the slide and allow the water to flow only in the opened part of the gate.

The bottom seal shall be made of resilient neoprene set into the bottom member of the frame and shall form a flush-bottom.

B. OPERATORS AND STEM

1. **STEM AND COUPLINGS.** The operating stem shall be of stainless steel designed to transmit in compression at least 2 times the rated output of the operating manual mechanism with a 40 lbs (178 N) effort on the handwheel.

The stem shall have a slenderness ratio (L/r) less than 200. The threaded portion of the stem shall have machined cut threads of the Acme type.

- C. **STEM GUIDES.** Stem guides shall be fabricated from type 304L (or 316L) stainless steel. The guide shall be equipped with an UHMWPE bushing. Guides shall be adjustable and spaced in accordance with the manufacturer's recommendation. The L/r ratio shall not be greater than 200.

- D. **STEM COVER.** Rising stem gates shall be provided with a clear polycarbonate stem cover. The stem cover shall have a cap and condensation vents and a clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.

- E. **LIFTING MECHANISM.** Manual operators of the types listed in the schedule shall be provided by the gate manufacturer.

All bearings and gears shall be totally enclosed in a weather tight housing. The pinion shaft of crank-operated mechanisms shall be constructed of stainless steel and supported by roller or needle bearings.

Each manual operator shall be designed to operate the gate under the maximum specified seating and unseating heads by using a maximum effort of 40 lbs (178 N) on the crank or handwheel, and shall be able to withstand, without damage, an effort of 80 lbs (356 N).

The maximum handwheel diameter shall be 24 inches (610 mm).

- F. **YOKE.** Self-contained gates shall be provided with a yoke made of structural members or formed plates. The maximum deflection of the yoke shall be 1/360 of the gate's span.

2.3 MATERIALS

PART	MATERIAL
Frame, yoke, stem guides, slide, stem extension	Stainless steel ASTM A-240 type 304L or 316L
Side seals, stem guide liner	Ultra high molecular weight polyethylene (UHMWPE) ASTM D-4020
Compression cord	Nitrile ASTM D2000 M6BG 708, A14, B14, E014, E034
Bottom seal	Neoprene ASTM D2000 Grade 2 BC 510
Threaded stem	Stainless steel ASTM A-276 type 303 MX or 316
Fasteners	ASTM F593 and F594 GR1 for type 304 and GR2 for type 316
Pedestal, handwheel and crank	Tenzaloy aluminum
Gasket (between frame and wall)	EPDM ASTM 1056
Stem cover	Polycarbonate ASTM D-3935
Lift nut, couplings	Manganese bronze ASTM B584 UNS-C86500

2.4 SCHEDULE

Gate Identification	1 – JB 7
Gate Type	Self Contained
Size - Width x Height	To fit 24" PVC PIPE
Operating Floor Elevation	5451.97
Invert Elevation	5452.97
Head - (Seating; Unseating)	3 FEET; 3 FEET
Mounting	CWX - Mounted on a concrete wall in front of a pipe

PART 3 – EXECUTION

3.1 CONTRACTOR RESPONSIBILITY

- A. The CONTRACTOR is responsible for furnishing and installing the PRODUCT including all site preparation, and other items necessary for the proper installation and operation of the PRODUCT.

3.2 STORAGE AND HANDLING

- A. The CONTRACTOR shall be responsible for the safe storage of the equipment until it is incorporated in the completed project.

3.3 EXAMINATION

- A. Examine Project conditions and completed Work and verify that dimensions are correct and project conditions are suitable for installation. Do not proceed with installation until satisfactory conditions have been corrected.
- B. Immediately correct all deficiencies and conditions which would cause improper execution of Work specified in this Section and subsequent Work.
- C. Proceeding with Work specified in this Section shall be interpreted to mean that all conditions were determined to be acceptable prior to start of Work.

3.4 INSTALLATION

- A. Install all products in accordance with manufacturer's instructions.
- B. Ensure that products are installed plumb and true, free of warp or twist, within tolerances specified by the manufacturer and as indicated in the contract documents.
- C. Surface – and Flange – Mounted Guides: Install guides with expansion anchors of type specified. Position guides at the required elevation, plumb and true, free of twist or warp.
- D. Recessed Guides: Box out slot in concrete to receive guides. Position guides at the required elevation, plumb and true, free of twist or warp. Grout guides in place in accordance with manufacturer's instructions.
- E. Plates: Install plates in accordance with manufacturer's instructions. Adjust to provide smooth operation.
- F. Clean surfaces in accordance with manufacturer's instructions.

3.5 OPERATIONS AND MAINTENANCE MANUALS

- A. Per Specification 01 77 23, the Manufacturer shall provide 5 copies of the operations and maintenance manuals which shall include the assembly and installation instructions. Operation and maintenance instructions which rely on vendor cut-sheets and literature which include general configurations, or require operating personnel to selectively read portions of the manual shall not be acceptable. Operation and maintenance instructions must be specific to equipment supplied in accordance with these specifications.

3.6 WARRANTY

- A. The PRODUCT and work shall be warranted against defects in material and workmanship for a period of one year. The warranty period shall begin after final inspection and acceptance by the project ENGINEER.

3.7 MEASUREMENT AND PAYMENT

- A. Work covered in this Section of Specifications and associated costs therewith shall be included in the contract price for the item to which the work applies. No separate payment shall be made.

END OF SECTION 35 20 16.26