

SECTION 16050
GENERAL PROVISIONS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to complete the electrical Work.
- B. Coordination:
1. Review installation procedures under other Sections and coordinate the installation of items that shall be installed with the formwork, walls, partitions, ceilings and panels.
 2. CONTRACTOR shall be responsible for the installation of all conduits, inserts and other items to be embedded in the concrete, or built into walls, partitions, ceilings or panels constructed by other contractors. CONTRACTOR shall provide other contractors with detailed plans or sketches of the location of said conduits and other built-in items as may be required. CONTRACTOR shall keep himself fully informed of the construction where conduits and other built-in items are to be installed. CONTRACTOR shall install said conduits and other built-in items in such a manner and within such time periods as will not unnecessarily delay the Work of the other contractors.
- C. General:
1. Interpretation of Drawings:
 - a. Dimensions shown on the Drawings that are related to equipment are based on one manufacturer's equipment. Coordinate the dimensions of the equipment furnished with the space allocated for that equipment.
 - b. The Drawings show the principal elements of the electrical installation. They are not intended as detailed working drawings for the electrical Work but as a complement to the Specifications to clarify the principal features of the electrical systems.
 - c. It is the intent of this Section that all equipment and devices, furnished and installed under this and other Sections, be properly connected and interconnected with other equipment so as to render the installations complete for successful operation, regardless of whether all the connections and interconnections are specifically mentioned in the Specifications or shown on the Drawings.

- D. Related Sections:
1. Division 1, General Requirements.
 2. Division 11, Equipment.
 3. Division 13, Special Construction (Instrumentation).
 4. Division 15, Mechanical.
- E. Temporary Power: Temporary light and power for construction purposes shall be provided in accordance with Division 1.
- F. Manufacturers and suppliers of equipment specified herein, and subcontractors furnishing and installing equipment, materials and appurtenances under this Division shall be required to review and satisfy all relevant requirements of the Contract Drawings. The CONTRACTOR, manufacturer, supplier, fabricator and/or subcontractors furnishing and/or installing equipment, services and specialties associated with this Division shall fully coordinate their efforts to avoid potential claims that are based on failure to review relevant Contract Documents, including the Contract Drawings.
- G. The CONTRACTOR shall retain ultimate responsibility under this Contract for equipment coordination, installation, operation and guarantee, and the CONTRACTOR shall furnish and install all labor, equipment materials, appurtenances, specialty items and services not provided by suppliers and/or subcontractors but required for complete and operable facilities.
- H. Utilities:
1. CONTRACTOR shall furnish and install electrical service pole and meter equipment as substantially indicated on the Drawings. All work shall be in conformance with the serving electric utility's requirements. Field coordination shall be the responsibility of the CONTRACTOR. CONTRACTOR shall make all arrangements for these services and pay all fees and acquire all permits to establish electrical service at this facility. The CONTRACTOR shall also coordinate with the electric utility and the OWNER for the de-commissioning of the existing electrical service. Upon project acceptance, the CONTRACTOR shall arrange for the service to be placed in the OWNER'S name.
- I. Change Orders:
1. In the event change orders are prepared, they shall each be itemized as to quantities in addition to labor, materials, and overhead.
 2. Pricing of change orders shall be done in compliance with the latest edition of "Means Electrical Cost Data" and pricing shall not exceed values tabulated therein.

1.2 QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies:
1. Permits: Obtain all permits required to commence work and, upon completion of the Work, obtain and deliver to ENGINEER a Certificate of Inspection and Approval from the State Board of Fire Underwriters or other authority having jurisdiction.
 2. Codes: Material and equipment shall be installed in accordance with the current standards and recommendations of the National Electrical Code, the National Electrical Safety Code and with local codes which apply. Where discrepancies arise between codes, the most restrictive regulation shall apply.
 3. Tests by Independent Regulatory Agencies: Electrical material and equipment shall be new and shall bear the label of the Underwriters' Laboratories, Inc., or other nationally-recognized, independent testing laboratory, wherever standards have been established and label service regularly applies.
 4. Utilities:
 - a. Electric utility company: Work in connection with the electrical service and utility metering shall be done in strict conformance with their requirements.
- B. Reference Standards: Electrical material and equipment shall conform in all respects to the latest approved standards of the following:
1. National Electrical Manufacturers Association.
 2. The American National Standards Institute.
 3. American Society for Testing and Materials.
 3. The Institute of Electrical and Electronic Engineers.
 4. Insulated Power Cable Engineers Association.
 5. National Fire Protection Association (NFPA) with emphasis on Part 70 and 70E the 2005 National Electrical Code (NEC) and Part 820, the Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
 6. National Electrical Safety Code (NESC).
 7. Underwriters' Laboratories (UL).
 8. Uniform Building Code (UBC).
 9. Occupational Safety and Health Administration (OSHA).
 10. National Electrical Contractors Association (NECA).
 11. Association Edison Illuminating Companies (AEIC).
 12. ENCOR standards and requirements.
 13. City of Prairie Electrical Ordinance.
- C. Assembled Products: The major components of any assembly such as motor control centers, reduced voltage starters, variable frequency drives, switchgear, switchboards and panelboards shall be manufactured by the assembly manufacturer.

1.3 SUBMITTALS

- A. General:
1. Conform to requirements of Division 1.
 2. A separate submittal shall be made for each specification section for Division 16. Each submittal shall be complete in nature to permit review by the ENGINEER.
- B. Shop drawings shall include the following information to the extent applicable to the particular item. Also refer to each specification section for additional requirements.
1. Manufacturer's name and product designation or catalog number.
 2. Electrical ratings.
 3. Conformance to applicable standards or specifications of AMT, ANSI, ASTM, ICEA, IEEE, ISA, NEC, NEMA, NFPA, OSHA, UL, or other organizations.
 4. Dimensioned plan, section, and elevations showing means for mounting, conduit connection, and grounding.
 5. Materials and finish specification, including paints.
 6. List of components including manufacturer's names and catalog numbers.
 7. Internal wiring diagrams indicating all connection to components and numbered terminals for external connections, in accordance with NFPA 79 standards. Reproduction of schematics as shown on the Contract Drawings is not acceptable and will be rejected.
 8. All equipment and material of a similar nature and use shall be of one manufacturer.

1.4 PROJECT CLOSEOUT

- A. Operation and Maintenance Data:
1. Conform to requirements of Section 01781, Operation and Maintenance Data.
- B. Record Drawings:
1. Contractor shall provide record drawings in AutoCAD V. 2000 or greater format.
 - a. Engineer will provide copies of original and supplemental construction drawings in AutoCAD V. 2000 or greater format for modification. The Contractor shall provide as built drawings in AutoCAD format by modifying the drawing to include all requirements of Section 01782 and the following:
 - a. One line wiring diagram of the power distribution systems.
 - b. Layout of actual in place manholes/handholes, ductbanks, cable trays, conduit and cables with schedule of conduit sizes and number and size of conductors.
 - c. Layouts of the grounding system arrangement.

- e. Control wiring diagrams with terminal numbers and all control devices identified.
- f. Wire tables in 8-1/2 x 11 bound form listing all conductors with record as-built taggings and landings, grouped by conduit number.
- g. Field changes of dimension and detail.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery of Materials: CONTRACTOR shall instruct the manufacturers and vendors as to the maximum shipping sizes of equipment that can be accommodated at the site.
- B. Storage of Materials: Conform to the requirements of Section 01661, Storage and Protection of Products.
- C. Handling of Materials: Conform to the requirements of Section 01651, Transportation and Handling of Products.

1.6 JOB CONDITIONS

- A. Existing Conditions:
 - 1. CONTRACTOR shall examine the site and existing facilities in order to compare them with the Drawings and Specifications with respect to the conditions of the premises, location of and connection to existing facilities and any obstructions which may be encountered.
 - 2. CONTRACTOR shall perform his work with due regard to safety and in a manner that will not interfere with the existing equipment or in any way cause interruption of any of the functions of the existing systems.
 - 3. Work shall be carried out with a minimum amount of disruption to the operation of the existing plant and with prior approval of ENGINEER. CONTRACTOR shall submit, for approval by ENGINEER, a detailed written procedure for work which affects operation of the existing systems, a detailed procedure for modifying any existing electrical equipment, and anticipated time required to complete the work and the required shutdown time, if any.
 - 4. Where the Work of CONTRACTOR ties in with existing installations, CONTRACTOR shall obtain the OWNER's written permission before removing any circuit from continuous use. Where duration of proposed outage cannot be tolerated by the OWNER, provide temporary power to maintain continuous service. CONTRACTOR shall take prior precautions and safeguards in connecting the Work with the existing operating circuits so as to prevent any interruption to the existing operating circuits. The tying in of Work, installed under this Contract, with the existing circuits shall be performed only in the presence of ENGINEER. Advance notice will be

required before any equipment is removed from service. CONTRACTOR shall notify ENGINEER in writing of his intention to do such work, giving full details.

1.7 CONTROL CABINETS AND PANELS

- A. All control cabinets and panels located in wet or in corrosive environments shall be NEMA 4X, 316 stainless steel, unless otherwise specified or noted on the Contract Drawings. Nominal/minimum dimensions are indicated on the Drawings, however it shall be the responsibility of the CONTRACTOR to determine the proper size.
- B. All outdoor panels shall be painted white and be provided with stainless steel sunshade structures painted white.
- C. Control panels shall be constructed in accordance with UL practices and shall meet the following requirements:
 - 1. A 1208V, 1 pole (or a 240V, 2 pole if indicated), 22KAIC, main circuit breaker to accept power from the designated source. All wire shall be copper (MTW type) and methods shall conform to UL 508 standards.
 - 2. Use control relays manufactured by Idec, series RH, or equal.
 - 3. Use timing relays manufactured by Idec, series RTE, or equal.
 - 4. Use 600V type terminal blocks. All field wiring shall be landed on a field wiring terminal block.
 - 6. Pilot lights shall be furnished in accordance with Section 16345, Medium Voltage Motor Control Centers.
 - 7. Provide identifying nameplates, attached with stainless steel screws.
- D. All control panels shall be submitted for review in accordance with this specification section and Division 1 requirements.

1.8 ELECTRICAL EQUIPMENT

- A. All electrical equipment shall be capable of operating successfully at full-rated load, without failure, with an ambient air temperature of 0 Deg F to 131 Deg F and an elevation of 1000 feet (MSL).
- B. All electrical devices and equipment shall have ratings based on 75 Deg C terminations.

1.9 AREA CLASSIFICATIONS

- A. Wet Locations: Materials, equipment, incidentals, and work in areas identified as wet locations shall meet NEC and NEMA requirements for wet locations. Enclosures

shall meet NEMA 4X requirements unless otherwise indicated. Conduits shall be terminated at enclosures with watertight, threaded hubs. The following areas shall be considered wet locations:

1. All outdoor areas, above and below grade.
- B. Dry Locations: Materials, equipment, incidentals, and work in areas not identified as wet or corrosive shall meet NEC and NEMA requirements for dry locations. Enclosures shall meet NEMA 12 requirements unless otherwise indicated on the Drawings. Conduits shall be terminated at enclosures with threaded hubs. The following areas shall be considered dry locations:
1. All remaining areas.

1.10 SCHEMATIC DIAGRAMS AND BLOCK DIAGRAMS

- A. Schematic diagrams and Block diagrams are provided for the CONTRACTOR'S guidance in fulfilling the operational intent of the Contract Documents. They do not necessarily show all required connections. Wiring such as wiring for push-to-test pilot lights or supply power to timing relays may not be shown for clarity.
- B. It shall be the CONTRACTOR'S responsibility to meet all safety and electrical codes, and to provide all equipment, appurtenances and specialty items required to meet the requirements of the Contract Documents.
- C. Review of wiring diagrams submitted by the CONTRACTOR shall not relieve the CONTRACTOR of the contractual responsibility to provide complete and successfully operating systems.

1.11 ELECTRICAL DEMOLITION

- A. The demolition of electrical power distribution equipment, instrumentation/control equipment, conduit, wire and appurtenances shall be in accordance with specification Section 01143 Maintenance of Plant Operations and Sequence of Work, Section 02220, Demolitions and in accordance with the Drawings.

1.12 SYSTEM STARTUP

- A. System Startup: Conform to the requirements of Section 01751, Starting and Placing Equipment in Operation; Section 01752, Field Tests of Equipment; and Section 01821, Instruction of Operations and Maintenance Personnel.

Trinity River Authority
TCWSP Water System Improvements –
Transfer Service Main

GENERAL PROVISIONS

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++

SECTION 16111
RIGID CONDUIT

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install rigid conduit and fittings to form complete, coordinated and grounded raceway systems.
2. The types of conduit required include the following:
 - a. Rigid Aluminum conduit for exposed in dry and wet locations.
 - b. Schedule 80 PVC for concrete encased duct bank runs.
 - c. PVC coated rigid aluminum or Schedule 80 PVC for conduit runs embedded in structural concrete slabs.

B. Coordination:

1. Conduit runs shown are diagrammatic.
2. Coordinate conduit installation with piping, ductwork, lighting fixtures and other systems and equipment and locate so as to avoid interferences.

C. Related Sections:

1. Section 01723, Cutting and Patching.
2. Section 16050, General Provisions.
3. Section 16112, Flexible Conduit.
4. Section 16114, Expansion Fittings.
5. Section 16116, Underground Ductbanks.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:

1. NEC Article 344, Rigid Metal Conduit.
2. NEC Article 352, Rigid Nonmetallic Conduit.
3. UL Standard No. 6, Rigid Metal Electrical Conduit.
4. UL Standard No. 514, Electrical Outlet Boxes and Fittings.
5. UL Standard No. 651, Schedule 80 PVC Conduit.
6. ANSI C80.1, Specification for Zinc Coated Rigid Steel Conduit.
7. ANSI C80.4, Specification for Fittings for Rigid Metal Conduit and Electrical Metallic Tubing.
8. NEMA TC2, Electrical Plastic Tubing, Conduit and Fittings.

9. NEMA TC3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 SUBMITTALS

- A. Shop Drawings: Submit for approval the following:
 1. Manufacturer's catalog cuts and technical information for the conduit, fittings and supports proposed for use.
 2. Layout drawings showing proposed routing of exposed conduits, conduits embedded in structural concrete and conduits directly buried in earth. Drawings shall show locations of pull and junction boxes and all penetrations in walls and floor slabs.
- B. Record Drawings: Include the actual routing of exposed and concealed conduit runs on record drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Rigid Aluminum Conduit, Elbows and Couplings:
 1. Material: Rigid, heavy wall, Aluminum, smooth interior, tapered threads and carefully reamed ends; 3/4-inch NPS minimum size.
 2. Manufacturer: Provide rigid aluminum conduit and fittings of one of the following:
 - a. Allied Tube and Conduit Corporation.
 - b. Republic Steel Corporation.
 - c. Triangle PWC Incorporated.
 - d. Or equal.
- B. PVC Coated Rigid Aluminum Conduit, Elbows and Couplings:
 1. Material: Rigid, heavy wall, Aluminum, smooth interior, tapered threads and carefully reamed ends; 3/4-inch NPS minimum size with a exterior factory coating of 40-mil thick polyvinyl chloride and an interior coating of 2-mil thick urethane.
 2. Color: Color of coating shall be the same on all conduit and fittings.
 3. Manufacturer: Provide PVC coated rigid aluminum conduit and fittings of one of the following:
 - a. Robroy Industries.
 - b. Ocal Blue.
 - b. Or equal.

C. Metallic Conduit Fittings:

1. Material and Construction: Aluminum bodies and covers. Outdoor units shall be gasketed and watertight. Gaskets shall be of an approved type designed for the purpose. Improvised gaskets are not acceptable. All units shall be threaded type with five full threads. All runs of rigid conduit shall be threaded, and all male threads shall be coated with non-galling thread compound prior to assembly. Material shall conform to ANSI C80.4 and shall be listed by UL. Fittings and bodies in or on PVC coated conduit runs shall have an exterior factory-applied coating of 40 mil thick polyvinyl chloride, an interior coating of 2-mil thick urethane, and V-seal gasketing.
2. Furnish and install conduit fittings as follows:
 - a. All conduits shall be terminated using a threaded hub.
 - b. Conduit field-applied hubs for sheet metal enclosures shall be aluminum body with recessed neoprene sealing ring threaded NPT insert, and shall be, T&B 370 AL series, or equal products by OZ/Gedney.
 - c. Conduit hubs for non-metallic enclosures shall be fiberglass polyester reinforced with aluminum core, complete with locknut and grounding bushing. All such hubs shall be Crouse-Hinds Type NHU, or equal.
 - d. Rigid metallic conduit chase nipples, split couplings, slip fittings, unions, reducers, and enlargers, shall be aluminum.
 - e. Rigid metallic conduit short els and long els shall be aluminum with NPT threaded hubs and male ends. Throats shall be smooth and free from burrs. All such fittings shall be OZ/Gedney Type "9" Series, Appleton, or equal.
 - f. Rigid metallic conduit split couplings shall have threaded body with split tightening shelves with neoprene sandwich. Furnish aluminum body. Such fittings shall be OZ type "SSP", or equal.
 - g. Rigid metallic conduit grounding bushings shall be aluminum body with threaded hub, bakelite insulated throat, and tin-plated copper ground lug. Furnish O-Z/Gedney type ABLG, or equal.
3. Manufacturer: Provide metallic conduit fittings of one of the following:
 - a. Robroy Industries.
 - b. Ocal Blue.
 - c. O-Z/Gedney Company.
 - d. Crouse-Hinds Company.
 - e. Or equal.

D. Non-Metallic Conduit:

1. PVC Plastic:
 - a. Material: Schedule 80 PVC plastic, NEMA Type EPC-80-PVD, 90EC rated, conforming to UL No. 651.
 - b. Manufacturer: Provide non-metallic conduit of one of the following:
 - 1) Amoco Chemicals Corporation.

- 2) Carlon, Division of Indian Head, Incorporated.
 - 3) Or equal.
 2. Non-Metallic Fittings: Form elbows, bodies, terminations, expansions and fasteners of same material and manufacturer as base conduit. Provide cement by same manufacturer as base conduit.
- E. Conduit Hubs:
1. Material: Shall be Myers Type NTZ Hubs. Threaded conduit hub, vibration proof, weather proof with captive O-ring seal, zinc metal with insulated throat. Hubs used on PVC coated conduit systems shall have a factory applied PVC coating.
 2. Use: Provide for all conduit terminations to boxes, cabinets and other enclosures located in areas designated as set locations.
 3. Manufacturer: Provide material manufactured by Myers Electrical Products Company, or equal.
- F. Conduit Tags:
1. Material: 19 gauge, 2-inch diameter round brass or stainless steel with back-filled legend, Style #08213 as manufactured by Seton Nameplate Corporation, or equal.
- G. Supporting Devices:
1. Mounting hardware, nuts, bolts, lockwashers, and washers, shall be Grade 316 stainless steel.
 2. Unless otherwise indicated, channel framing and supporting devices shall be manufactured of ASTM 6063, T06 grade aluminum; 1-5/8" width x 3-1/4" deep (double opening type). Clamp nuts for use with channels shall be type 316 stainless steel.
 3. Where indicated, furnish grade 316 stainless steel slotted channel members 1-5/8" side x 1-5/8" deep or 1 5/8" x 3 1/4" deep, doubled-faced type. All hardware and conduit clamps shall be grade 316 stainless steel.
 4. Conduit clamp supports for terminating conduits onto cable trays shall be with adjustable angle clamp. Fittings shall be provided with type 316 stainless steel hardware. Furnish OZ/Gedney type CTC products.
 5. All such channel members and fitments shall be B-Line, Unistrut, or equal.
 6. Conduit straps, and associated nuts, lockwashers and bolts for use with channels shall be 316 stainless steel with 316 stainless steel hardware. Furnish B-Line products or equal.
 7. After-set concrete inserts (drilled expansion shields "D.E.S.") shall consist of two types. For anchors to accommodate 5/16" diameter bolts and smaller, provide HILTI "HDI" series 316 stainless steel anchors. For anchors to accommodate 3/8" diameter and larger bolts, provide HILTI "HVA" series with 316 stainless steel threaded inserts.

8. Hanger rod shall be 3/8" minimum diameter Type 316 stainless steel all-thread.
9. Nest-back or clamp-back conduit supports shall be two-piece aluminum devices. Furnish Crouse-Hinds "MW+CB", OZ/Gedney 140NG Series, or equal.
10. One-hole conduit clamps shall be aluminum type, Crouse-Hinds Type "MW", T&B 1270/1280 Series, OZ/Gedney "14G" Series, or equal cast aluminum products.
11. Conduit beam clamps shall be hot-dip galvanized malleable iron and shall be as follows:
 - a. Right Angle: OZ/Gedney Type "UBCG", or equal.
 - b. Parallel: OZ/Gedney Type "UPCG", or equal.
 - c. Edge: OZ/Gedney Type "UECG", or equal.
12. Hanger rod beam clamps shall be clamp type with hardened 316 SS, bolt, Steel City "500" Series, Crouse-Hinds type "MW", or equal. Furnish Swivel stud for each rod make-up.
13. Conduit "J" hangers shall consist of 316 stainless steel straddle with detachable bolt. Furnish Kindorf type "C-149", Unistrut "J-1200" Series, or equal.
14. Conduit "U" bolts shall be 316 stainless steel with 316 stainless steel hex-head bolts with 316 stainless steel nuts.
15. Equipment stands for supporting devices such as control stations, device boxes and the like, shall consist of a welded aluminum c-channel and plate aluminum floor plate as detailed on the drawings. Equipment stands shall be constructed of all aluminum.

H. Coating Compounds:

1. Conduit thread coating compound shall be conductive, non-galling, and corrosion-inhibiting. Furnish Crouse-Hinds Type "STL", Appleton Type "ST", or equal.
2. Plastic compound for field-coating of ferrous material products shall be PVC in liquid form that sets-up semi-hard upon curing. Furnish Rob Roy "Rob Kote", Sedco "Patch Coat", or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in conformance with National Electrical Code requirements.
- B. Supports:
 1. Rigidly support conduits with clamps, hangers or Unistrut channels.
 2. Support single conduits by means of 316 stainless steel clamps in combination with one-screw back plates, to raise conduits from the support surface. Support

multiple runs of conduits on trapeze type hangers with steel horizontal members and threaded hanger rods, Kindorff or equal. Rods shall be not less than 3/8-inch diameter, and shall be 316 stainless steel.

3. For PVC coated rigid aluminum conduit runs, supports and hardware shall be stainless steel.
- C. Fastenings: Fasten raceway systems rigidly and neatly to supporting structures by the following methods:
1. To Wood: Wood screws.
 2. To Hollow Masonry Units: Toggle bolts.
 3. To Brick Masonry: Price expansion bolts, or equal.
 4. To Concrete: Phillips; Hilti Corporation; or equal, anchors.
 5. To Steel: Welded threaded studs, beam clamps or bolts with lockwashers or locknuts.
- D. Exposed Conduit:
1. Install parallel or perpendicular to structural members or walls.
 2. Wherever possible, run in groups. Provide 316 stainless steel conduit racks of suitable width, length and height and arranged to suit field conditions. Provide support at every 10 feet minimum.
 3. Install on structural members in protected locations.
 4. Locate clear of interferences.
 5. Maintain 6-inches from hot fluid lines and 1/4-inch from walls.
 6. Install vertical runs plumb. Unsecured drop length shall not exceed 12 feet.
- E. Conduit Embedded in Concrete:
1. Separation: Three times outer diameter of larger conduit center to center.
 2. Minimum Slab Thickness:
 - a. With no crisscrossing of conduit, three times outer diameter of conduit.
 - b. With crisscrossing of conduits, four times outer diameter of larger conduit.
 3. Run conduit in center of slab.
 4. Before concrete is placed, make the necessary location measurements of the conduit to be embedded so that the information is available to prepare record drawings.
 5. All conduits entering or exiting concrete shall be PVC coated 12 inches on each side of air/concrete interface.
- F. Individual Underground Conduits:
1. Install individual underground conduits a minimum of 24-inches below grade unless otherwise indicated or as required to avoid existing obstructions.
 2. Perform all excavation, bedding, backfilling and surface restoration including pavement replacement where required.

3. Make conduit connections watertight.
 4. Protect conduits by the following means: Provide minimum 3-inches of concrete all around PVC schedule 80 type conduits.
- G. Empty Conduits, designated as CO (conduit only), EMPTY, or SPARE on the Drawings:
1. Install glass-fiber reinforced tape pull cord, with foot-marked identification along its length, in each empty conduit and cap conduits not terminating in boxes with permanent fittings designed for the purpose. Furnish pull cord by Thomas, Greenlee, or equal.
 2. Identify each empty conduit with a round brass tag showing the conduit number indicated on the Drawings, terminus of other end of conduit, and trade size of the conduit.
- H. Field Bends: No indentations. Diameter of conduit shall not vary more than 10 percent at any bend.
- I. Joints:
1. Apply conductive compound to all joints before assembly.
 2. Make up joints tight and ground thoroughly.
 3. Use standard tapered pipe threads for conduit and fittings.
 4. Cut conduit ends square and ream to prevent damage to wire and cable.
 5. Use full threaded couplings. Split couplings are not permitted.
 6. Use strap wrenches and vises to install conduit. Replace conduit with wrench marks.
- J. Terminations:
1. Install insulated bushings on conduits entering boxes or cabinets, except threaded hub types. Double bushings for insulation wiring through sheet metal panels shall consist of mating male and female threaded phenolic bushings. Phenolic insulation shall be high-impact thermosetting plastic rated 150 degrees C. Furnish O-Z/Gedney Type "ABB", or equal.
 2. Provide locknuts on both inside and outside of enclosure for grounding.
 3. Bushings are not to be used in lieu of locknuts.
- K. Moisture Protection:
1. Plug or cap conduit ends at time of installation to prevent entrance of moisture or foreign materials.
 2. Make underground and embedded conduit connections watertight.
 3. Thruwall Seals: Install for conduits passing through new exterior subsurface walls or base slabs of buildings and for conduits passing through existing exterior walls. For individual exposed conduits passing through interior walls,

install non-metallic sleeves to protect the conduit against action of alkaline substances which may be present.

4. Drainage: Pay particular attention to drainage for conduit runs. Wherever possible, install conduit runs so as to drain to one end and away from buildings. Avoid pockets or depressions in conduit runs. Where conduits enter buildings below grade, seal inside of conduit to form a watertight seal around cables to prevent the entry of water into building. Sealant shall be Silicone and shall form an elastomeric compression seal. Sealant shall be Fire Barrier 2001 Silicone RTV Foam or equal.

L. Corrosion Protection:

1. Conduit Curb:

- a. In concrete slabs or floors, provide a 2-inch high curb extending 2-inches from the outer surface of the conduit penetrating the floor, to prevent corrosion.
- b. Terminate conduit stub-ups in couplings, slightly above the finished concrete curb.
- c. Paint the stub-up with Scotch-Clad Protective Coating #1706 or equal, a minimum of 6-inches above and below the finished surface of the concrete.

2. Dissimilar Metals:

- a. Take every action to prevent the occurrence of electrolytic action between dissimilar metals.
- b. Do not use copper products in connection with aluminum work, and do not use aluminum in locations subject to drainage of copper compounds on the bare aluminum.
- c. Back paint aluminum in contact with masonry or concrete with two coats of aluminum-pigmented bituminous paint.

- M. Core drill for individual conduits passing through existing concrete walls or slabs. Obtain authorization from ENGINEER/OWNER prior to core drilling. Seal spaces around conduit in accordance with Division 1 requirements.

N. Non-Metallic Conduit:

1. Install in accordance with manufacturer's recommendations.
2. Join sections in accordance with manufacturer's installation procedures for push-fit, bell and spigot type joints, if applicable, or with manufacturer's recommended cement.
3. During installation provide expansion fittings for expansion and contraction to compensate for temperature variations. Expansion fittings shall be watertight and of the type suitable for direct burial.
4. Make transition to PVC coated aluminum conduit before making turn up to enclosures, equipment, lightpoles, etc.

5. Provide watertight expansion/deflection fittings at all wall and floor penetrations of all buildings and equipment concrete pads.

3.2 TESTING

- A. Test conduits by pulling through each conduit a cylindrical mandrel not less than two pipe inside diameters long, having an outside diameter equal to 90 percent of the inside diameter of the conduit.
- B. Maintain a record, by number, of all conduits testing clear.

3.3 IDENTIFICATION

- A. Tag all conduits at the ends and in all intermediate boxes, chambers, handholes and other enclosures. Fasten tags to conduits with 316 stainless steel wire. Where this method is not practical, fasten to the adjacent masonry by means of expansion bolts. Identify each conduit with a round brass tag or stainless steel showing the conduit number indicated on the Drawings. Where conduits terminate into bottoms of motor control centers, each conduit tag shall include the conduit number indicated on the Drawings, trade size of the conduit, AWG size of conductors, quantity of each size of conductor, and function of circuitry.
- B. Revise conduit identification numbers on record drawings, if necessary.

++ END OF SECTION ++

SECTION 16112
FLEXIBLE CONDUIT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install flexible metallic conduit and fittings.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
1. NEC Article 350, Liquid tight Flexible Metal Conduit.
 2. UL Standard No. 360, Liquid-Tight Flexible Aluminum Conduit.

1.3 SUBMITTALS

- A. Shop Drawings: Submit for approval the following:
1. Manufacturer's catalog cuts and technical information for flexible conduit and fittings proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Flexible Conduit (Non-hazardous Areas):
1. Material: Flexible interlocking aluminum core with smooth, abrasion resistant, liquid-tight, polyvinyl chloride cover. Continuous copper ground built in for sizes 3/4-inch through 1-1/4 inch. Material shall be UL listed.
 2. Product and Manufacturer: Provide one of the following:
 - a. Flexiguard by O-Z/Gedney.
 - b. Liguatite Type A.L.T. by Electric-Flex Company.
 - c. Or equal.

B. Flexible Conduit Fittings:

1. Material and Construction: Liquid-tight flexible conduit fittings shall be aluminum body with internal locking ring and ground cone plus external ground wire fitting. Fittings shall adapt the conduit to standard threaded connections, shall have an inside diameter not less than that of the corresponding standard conduit size and shall be UL listed.
2. Manufacturer: Provide flexible conduit fittings of one of the following:
 - a. Crouse-Hinds Company.
 - b. Appleton Electric Company.
 - c. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install at motors 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 three feet maximum.
- B. Install in conformance with National Electrical Code requirements.

++ END OF SECTION ++

SECTION 16114
EXPANSION FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as required to furnish and install conduit expansion and deflection fittings.

1.2 QUALITY ASSURANCE

- A. Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
1. NEC Article 300, Wiring Methods.
 2. UL Standard 514, Electrical Outlet Boxes and Fittings.
 3. UL Standard 467, Electrical Grounding and Bonding Equipment.

1.3 SUBMITTALS

- A. Shop Drawings: Submit for approval the following:
1. Manufacturer's technical information for expansion and deflection fittings proposed for use.
 2. Listing of locations where fittings are to be used.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cast gray iron alloy or bronze end couplings, malleable iron or aluminum body, stainless steel clamps and tinned copper braid bonding jumper. Fittings shall be watertight, corrosion-resistant UL listed and compatible with the conduit system.
- B. Product and Manufacturer: Provide one of the following:
1. Type DX for expansion/deflection or AX for expansion only by O-Z Gedney Company.
 2. Type XD for expansion/deflection or XJ for expansion only by Crouse Hinds Company.
 3. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fittings in conformance with the National Electrical Code where necessary to compensate for thermal expansion and contraction.
- B. Install expansion/deflection fittings where conduits cross structural expansion joints.
- C. Where required in non-metallic conduit and duct systems, provide necessary couplings to make transition to the threaded metallic fitting.

++ END OF SECTION ++

SECTION 16116
UNDERGROUND DUCT BANKS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install underground duct banks. A duct bank consists of two (2) or more conduits.
- B. Coordination: Duct bank routing on the Drawings is diagrammatic. Coordinate installation with piping and other underground systems and structures and locate clear of interferences. Existing duct banks will be encountered. Ductbanks provided under this contract shall be installed under existing duct banks to avoid interference.
- C. The CONTRACTOR shall provide the duct banks (conduit only with pull-string) for the serving electric utility's primary power feeder circuits, where service duct bank are indicated on the Drawings. The CONTRACTOR shall coordinate with the electric utility company for all requirements, tie-ins, and shall coordinate the exact routing, including all road crossings.
- D. Existing concrete and asphalt roadways which require cutting shall be repaired to match existing.
- E. Related Sections:
 - 1. Section 02321, Trench Excavation and Backfill.
 - 2. Section 03300, Concrete, Reinforcement and Formwork.
 - 3. Section 16111, Rigid Conduit.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the National Electrical Code and National Electrical Safety Code.

1.3 SUBMITTALS

- A. Shop Drawings: Submit for approval the following:
 - 1. Layouts showing the proposed routing of duct banks.
 - 2. Profiles of duct banks showing crossings with piping and other underground systems.
 - 3. Typical cross sections.

4. Installation procedures.
 5. Manufacturer's information on saddles, separators, and spacers proposed for use.
- B. Record Drawings: Include the actual location of manholes/handholes (if undiscovered routing requires) and the actual routing of underground duct runs on record drawings. Provide elevation to top of duct bank and coordinates of duct bank of record drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Backfill: Select backfill in accordance with Section 02321, Trench Excavation and Backfill.
- B. Reinforcement: In accordance with this section.
- C. Concrete: In accordance with Section 03300, Concrete, Reinforcement and Formwork.
- D. Conduit: Schedule 80 PVC conduit in accordance with Section 16111, Rigid Conduit. Use PVC coated rigid aluminum conduit type elbows/sweeps in accordance with Section 16111, Rigid Conduit.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide excavation and backfilling required for ductbank installation.
- B. Make duct bank installations and penetrations through foundation walls watertight.
- C. Top of ductbanks shall be a minimum of 24-inches below grade, unless otherwise approved by the ENGINEER.
- D. Assemble duct banks using non-magnetic saddles, spacers and separators. Position separators to provide 3-inch minimum concrete separation between the outer surfaces of the ducts. Use support systems as manufactured by Carlon, Underground Devices, or equal.

- E. Provide a 3-inch minimum concrete covering on both sides, top and bottom of concrete envelopes around conduits. Add red dye to concrete, mix in concrete truck prior to placement, used for envelopes for easy identification during subsequent excavation. Provide Green dye concrete for instrumentation and communication duct banks.
- F. Firmly fix ducts in place during pouring of concrete. Carefully spade and vibrate the concrete to ensure filling of all spaces between ducts.
- G. Make bends with sweeps of not less than 48-inch radius or 5-degree angle couplings for conduits sized 4 inches and larger.
- H. Make a transition from non-metallic to rigid aluminum conduit where duct banks enter structures or turn upward for continuation above grade. Continue ducts inside buildings with rigid aluminum conduit.
- I. Reinforce duct banks as follows:
 - 1. Unless otherwise noted on the Drawings, reinforce with No. 4 longitudinal steel bars placed at each corner and along each face at a maximum parallel spacing of 18-inches on centers and No. 4 tie-bars transversely placed at 18-inch maximum longitudinal intervals.
 - 2. Maintain a maximum clearance of 1-inch from bars to the edge of the concrete encasement.
 - 3. Reinforcement shall be used where duct banks are under roadways.
- J. Where ducts enter structures such as manholes, handholes, pullboxes, transformer and switchgear compartments, or buildings, terminate the ducts in suitable end bells, insulated bushings or couplings on steel conduits.
- K. Do not backfill with material containing large rock, paving materials, cinders, large or sharply angular substances, corrosive material or other materials which can damage or contribute to corrosion of ducts or cables or prevent adequate compaction of fill.
- L. Slope duct runs for drainage toward manholes and away from buildings with a slope of approximately 3-inches per 100 feet.
- M. Install a bare stranded copper duct bank ground in each duct bank envelope. Make ground electrically continuous throughout the entire duct bank system and connect to switchgear and motor control center (MCC) ground buses and to steel conduit extensions of the underground duct system.

- N. After completion of the duct bank and prior to pulling cable, pull a mandrel, in accordance with section 16111.3.2, through each duct. Then pull a rag swab or sponge through to make certain that no particles of earth, sand or gravel have been left in the duct.
- O. Install a warning ribbon approximately 12-inches below finished grade over all underground duct banks. The identifying ribbon shall be a PVC semi-metallic tape, 4-inches wide, yellow color, permanently imprinted with "CAUTION BURIED ELECTRIC LINE BELOW" in black letters.
- P. Plug and seal watertight all empty spare ducts entering buildings and structures. Seal watertight all ducts in use entering buildings and structures.
- Q. Install duct banks in conformance with National Electrical Code, and National Electrical Safety Code.

++ END OF SECTION ++

SECTION 16121
600 VOLT CABLE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install 600-volt cable.
 2. The types of cable required include the following:
 - a. Insulated cable for installation in raceways.
 - b. Insulated cable for installation in cable trays.
- B. Related Sections:
1. Section 16124, Instrumentation Cable.
 2. Section 16390, Grounding Systems.

1.2 QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies:
1. Codes: Cable shall be installed in accordance with the standards and recommendations of the National Electrical Code and with local codes which apply. Where discrepancies arise between codes, the most restrictive regulation shall apply.
 2. Tests by Independent Regulatory Agencies: Cable shall bear the label of the Underwriters' Laboratories, Inc.
- B. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
1. ASTM B 3, Soft or Annealed Copper Wire.
 2. ASTM B 8, Concentric-Lay-Stranded Copper Conductors, Hard, Medium-hard or Soft.
 3. IPCEA S-66-524, NEMA WC7-1971, Cross-linked-thermosetting-polyethylene-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 4. National Electrical Code.
 5. UL Standard No. 44, Wires and Cables, Rubber-Insulated.

1.3 SUBMITTALS

- A. Shop Drawings: Submit for approval the following:
 - 1. Manufacturer's literature, specifications, and engineering data for 600 volt insulated cable.
- B. Test Records: Submit for review copies of written records of field insulation resistance test results.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Insulated Cable In Raceways:
 - 1. Material: Single or multi-conductor copper cable conforming to ASTM B 3 and B 8 with flame-retardant, moisture and heat resistant thermoplastic insulation rated 90 Deg C in dry locations and 75 Deg C in wet locations and listed by UL as type XHHW.
 - 2. Application: Use type XHHW for all sizes unless otherwise indicated.
 - 3. Wire Sizes: Not smaller than No. 12 AWG for power and lighting and No. 14 AWG for 120-volt control circuits.
 - 4. Stranding: All 600 volt cable shall be stranded, except for No. 12 AWG and No. 10 AWG cables used for lighting and receptacles which may be solid.
 - 5. Cable shall be color-coded as indicated under Part 3 of this specification.
 - 6. Manufacturer: Provide cable of one of the following:
 - a. The Okonite Company.
 - b. Or equal.
- B. Cable for Installation in Trays:
 - 1. Material: Factory assembled cable, single or multi-conductor as required by the CONTRACT DRAWINGS, type XHHW bearing the UL label, type TC and specifically approved for installation in cable trays.
 - 2. Cable shall be color-coded as indicated under Part 3 of this specification.
 - 3. Manufacturer: Provide tray cable of one of the following:
 - a. The Okonite Company.
 - b. Or equal.
- C. Cable Connectors, Solderless Type:
 - 1. For wire sizes up to #6 AWG, use compression type.
 - 2. Product and Manufacturer: Provide one of the following:
 - a. T & B Sta-Kon.
 - b. Burndy Hylug.

- c. Or equal.
 3. For sizes #4 – 4/0 AWG, use either compression type or bolted type with silver-plated contact faces.
 4. For sizes #250 kcmil and larger, use connectors with at least 2 cable clamping elements or compression indents and provision for at least 2 bolts for joining to apparatus terminal.
 5. Properly size connectors to fit fastening device and wire size.
- D. Insulating and Tape Products:
1. General Purpose Electrical Tape: 7 mil thick stretchable vinyl plastic, pressure adhesive type, "Slipknot Grey", 3M Scotch 33 +, or equal.
 2. Insulation Void-Filling Tape and High Voltage Bedding Tape: Stretchable ethylene propylene rubber with high-tack and fast fusing surfaces. Tape shall be rated for 90 degrees C continuous, 130 degrees C overload, and shall be moisture-proof. Void filling tape shall be "Plysafe", 3M Scotch 23, or equal.
 3. High Temperature Protective Tape: rated 180(0)C continuous indoor/outdoor, stretchable, self-bonding silicone rubber. High temperature tape shall be Pylsil # 3455, 3M Scotch 70, or equal.
 4. Insulation Putty Filler Tape: Plymouth #32074, 3M Scotchfill, or equal.
 5. Arc and Fireproofing Tape: Plymouth # 3318, 3M Scotch #70 or equal.
 6. Color Tape: 5-mil stretchable vinyl with permanent solid color. Furnish and install color tape for wire color-coding as specified in Part 3 of this specification. Slipknot 45 by Plymouth Company, Scotch #35 by 3M Corporation, or equal.
- E. Cable and Conductor Markers:
1. Each conductor shall be tagged with its associated conduit number followed by its discrete number; e.g., 1310-1, 1310-2, 1310-3, 1310-4, 1310-5, 1310-6, 1310-7 for seven conductors in Conduit 1310. Marker shall be a PVC sleeve type marker with white background and black permanent letters, machine-printed, and solvent resistant.
 2. Product and Manufacturer: Provide the following:
 - a. Raychem TMS-SCE by Tyco Electronics Corporation.
 - b. Or equal.
- F. Wire and Cable Tagging Tables:
1. CONTRACTOR shall develop and maintain during the construction period "WIRE TAG TABLES" for all Control and Instrumentation Conductors as they are installed. Tables shall be formatted to show conduit/cable/wire number, origin and termination, with the conduit number and each with its conductor listed as follows: 1310-1, 1310-2, 1310-3, etc. A 1" wide "Remarks" column shall be provided for special notes relating to the cable or group of conductors. Sheets shall be 8-1/2" x 11" for insertion in 3-ring binders.

2. CONTRACTOR shall submit an actual sample encased in a plastic envelope for approval within 120 days of Notice to Proceed.
3. At completion of construction, the CONTRACTOR shall provide four (4) complete sets of typed wire tables in 3-ring binders. Each sheet shall be protected with a plastic envelope. binders shall be identified as Vol. I, Vol. II, etc. The tables shall be in numerical order.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all cables complete with proper terminations at both ends. Check and correct for proper phase sequence and proper motor rotation.
- B. Pulling:
 1. Use insulating types of pulling compounds containing no mineral oil.
 2. Pulling tension shall be within the limits recommended by the wire and cable manufacturer.
 3. Use a dynamometer where mechanical means are used.
 4. Cut off section subject to mechanical means.
- C. Bending Radius: Limit to 6 times cable overall diameter.
- D. Slack: Provide maximum slack at all terminal points.
- E. Splices:
 1. Install cable continuous, without splice, from termination to termination.
 2. Where indicated on the Drawings, splice in junction box using terminal boards, including splices in manholes and/or handholes.
 3. Splices in conduits are not allowed.
- F. Identification:
 1. Each cable and conductor shall be identified in each pullbox, manhole and each termination point with circuit identification markers. The markers shall be printed using a Tyco Electronics Corporation T312M (thermal transfer) printer or equal.
- G. Phase Identification/Color Coding: Color-coding shall be as follows. Non-factory color-codes cables shall be marked with color tape specified herein at each termination location.
 1. All three-phase circuits shall be identified at manholes/handholes, switchgear, motor control centers, control panels and panelboards.

2. Three phase 480/277-volt systems shall have the following color-coding:
Phase A-Brown
Phase B-Orange
Phase C-Yellow
Neutral- Grey
3. Three phase 208/120-volt systems shall have the following color-coding:
Phase A-Black
Phase B-Red
Phase C-Blue
Neutral- White
4. Single phase 240/120-volt systems shall have the following color-coding:
Phase A-Black
Phase B-Red
Neutral-White
5. Grounding wire shall be green.

3.2 EQUIPMENT TESTING

- A. Test each electrical circuit after permanent cables are in place to demonstrate that the circuit and connected equipment perform satisfactorily and that they are free from improper grounds and short circuits. Provide written request to the OWNER two weeks prior to testing. OWNER must be present for the test.
- B. Individually test 600 volt cables for insulation resistance between phases and from each phase to ground. Test after cables are installed and before they are put in service with a Megger whose rating is suitable for the tested circuit. Tests shall meet with the applicable specifications of IPCEA S-66-524 and NEMA WC7-1971. Use the test form provided at the end of this section.
- C. The insulation resistance for any given conductor shall not be less than the value recommended by the IPCEA or a minimum of 25 megohm for 600 volt and less service, if not IPCEA listed. Any cable not meeting the recommended value or which fails when tested under full load conditions shall be replaced with a new cable for the full length.
- D. Install in accordance with the National Electrical Code.

Trinity River Authority
Water Delivery System Improvements

600 VOLT CABLE

600V. CABLE TEST REPORT

PROJECT: _____ PROJECT NUMBER: _____
 OWNER: _____
 CONTRACTOR: _____
 ENGINEER: _____
 INSTALLED BY: _____ REPORT NO.: _____
 DESCRIPTION: _____ SPEC. NO. _____

RESISTANCE TESTER: _____ SERIAL NO. _____ VDC
 MFGR. _____ MODEL _____ MAX VOLTAGE _____
 RANGE _____ MEGOHMS _____

Ambient Temp _____ F. _____ %RH _____
 Date Temp. _____ F. _____ Date _____

Station	Sleeve Identification	Cable Size	Cable Insulation	Cable Mfgr.	Raceway Cond.*	Insulation Resistance (Megohms after 15 sec.)			Retest Req'd
						Phase A	Phase B	Phase C	
From									
To									

*RACEWAY CONDITIONS:
 A. ABOVE GROUND CONDUIT D. JACKETED CABLE
 B. BELOW GROUND CONDUIT E. ARMORED CABLE (ABOVE GROUND)
 C. TRAY CABLE F. ARMORED CABLE (BELOW GROUND)

Test By: _____ Date: _____
 Witness By: _____ Date: _____

600V CABLE TEST REPORT

CHECK LIST

1. Check exposed cable for physical damage.
2. Check terminations of exposed cable where applicable.
3. Observe ground lead of insulation tester to be solidly connected to grounding source. Re-check continuity of ground lead to source each time ground lead is moved.
4. Check cable tested for size, type, phasing, wire tags and terminations per plans, specifications and wiring diagrams.

COMMENTS

Please list discrepancies noted on above items.

++ END OF SECTION ++

PROPOSITION 1.1

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SECTION 16124
INSTRUMENTATION CABLE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, and terminate instrumentation system cables.
2. The types of cable include the following:
 - a. Shielded instrument cable.

B. Related Work:

1. Division 1.

1.2 SUBMITTALS

A. Shop Drawings: Submit for approval the following:

1. Manufacturer's technical information for instrumentation cables proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Single Shielded Pair (TS Pair) Cable:

1. Bare, soft annealed copper, 7 strand, PVC insulated conductors, #16 AWG minimum, twisted with aluminum-polyester shield, stranded tinned 20 AWG copper drain wire and PVC outer jacket. Rated for 600 volts. UL listed for cable tray use, sunlight resistant.
2. Manufacturer: Provide shielded cable of one of the following:
 - a. Okonite Company, Okoseal-N Type P-OS.
 - b. Or equal.

B. Multi-paired and Multi-triad Shielded Instrument Cable:

1. Bare, soft annealed copper, 7 strand, PVC insulated conductors, #16 AWG minimum, twisted in pairs/triads with aluminum-mylar shield over each pair/triad, silicone rubber fiberglass fire barrier tape, tinned copper drain wire,

aluminum mylar overall shield, PVC outer jacket. Rated for 600 volts. UL listed for cable tray use, sunlight resistant

2. Manufacturer: Provide shielded cable of one of the following:
 - a. Okonite Company, Okoseal-N Type SP-OS.
 - b. Or equal.

C. Single Unshielded Pair Instrument Cable

1. Bare, soft annealed copper, 7 strand, PVC insulated conductors, #16 AWG minimum, twisted. Outer jacket to be PVC. Rated for 600 volts minimum. The abbreviation "TW" is used on the Drawings to indicate unshielded twisted pair.
2. Manufacturer: Provide unshielded cable of one of the following:
 - a. Okonite Company.
 - b. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in conduit separate from power cables unless otherwise noted.
- B. Ground shield of shielded cables at one end only and as recommended by instrument manufacturer.
- C. Terminate stranded conductors with pre-insulated crimp type spade or ring torque terminals properly sized to fit fastening device and wire size.
- D. Install and terminate vendor furnished cable in accordance with vendor equipment requirements.
- E. Install in conformance with the National Electrical Code.

3.2 TESTING

- A. Test all 600 volt wiring in conformance with the requirements of Section 16121, 600 Volt Cable.
- B. Test shielded instrumentation cable shields with an ohmmeter for continuity along the full length of the cable and for shield continuity to ground.
- C. Connect shielded instrumentation cables to a calibrated 4-20 milliamp DC signal transmitter and receiver. Test at 4, 12, and 20 milliamp transmitter settings.

D. The OWNER shall be present for all testing.

++ END OF SECTION ++



SECTION 16130
CONDUIT BODIES AND OUTLET BOXES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install outlet boxes for mounting wiring devices and lighting fixtures.
- B. Related work:
 - 1. Division 1.
 - 2. Section 16131, Pull and Junction Boxes.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
 - 1. NEC Article 314, Outlet, Device, Pull, and Junction Boxes; Conduit Bodies; Fittings; and Handhole Enclosures.
 - 2. UL Standard No. 514, Electrical Outlet Boxes and Fittings.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Conduit Bodies (for use in non-corrosive areas):
 - 1. Material: Aluminum (material shall match conduit). Covers for damp and/or wet location use shall be gasketed cast aluminum with "wedge-nut" clamps. Covers for dry locations shall be cast aluminum and gasketed and hardware shall be 316 stainless steel. All covers shall be equipped with clamp type clevises.
 - 2. Manufacturer: Provide conduit bodies of one of the following:
 - a. Form 7, by Crouse-Hinds Company.
 - b. Form FM7, by Appleton.
 - c. Or equal.
- B. Conduit Bodies (for use in corrosive areas):

1. Material: As specified above but shall have 40 mil plastic coated PVC jacket and 2 mil interior coating as specified for plastic coated rigid aluminum conduit.
 2. Manufacturer: Provide conduit bodies for use in corrosive areas of one of the following:
 - a. Plasti-bond red aluminum fittings, by Robroy Industries.
 - b. Or equal.
- C. Device Boxes:
1. Material: Sand-cast copper free aluminum, PVC coated in corrosive locations.
 2. Device Cover Plates:
 - a. Brushed stainless steel Type 302 alloy for dry areas. Cover plates for receptacles powered from an uninterruptable power supply (UPS) source shall be mechanically stamped/engraved as follows: UPS POWER
 - b. Gasketed spring door type for switches located in wet locations. Weatherproof while in use type covers for receptacles, as detailed on the Drawings.
 - c. Stainless steel screws and hardware.
 3. Manufacturer: Provide device boxes of one of the following:
 - a. Crouse-Hinds Company.
 - b. Appleton Electric Company.
 - c. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fasten boxes rigidly and neatly to supporting structures.
- B. For units mounted on masonry or concrete walls, provide suitable 2-inch spacers to prevent mounting back of box directly against wall.
- C. Leave no open conduit holes in boxes. Close unused openings with capped bushings.
- D. Label each circuit in boxes and identify with tag.
- E. Install in conformance with National Electrical Code.

++ END OF SECTION ++

SECTION 16131
PULL AND JUNCTION BOXES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install pull and junction boxes.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
1. NEC Article 314, Outlet, Device, Pull, and Junction Boxes; Conduit Bodies; Fittings; and Handhole Enclosures
 2. UL Standard No. 50, Electrical Cabinets and Boxes.
 3. UL Standard No. 886, Electrical Outlet Boxes and Fittings for Use in Hazardous Locations.

1.3 SUBMITTALS

- A. Shop Drawings: Submit for approval the following:
1. Manufacturer's technical information for pull and junction boxes proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Pull and Junction Boxes:
1. Material and Construction:
 - a. Aluminum or 316 stainless steel bodies and covers.
 - b. Neoprene gaskets. Gaskets shall be of an approved type designed for the purpose. Improvised gaskets are not acceptable.
 - c. Stainless steel cover screws.
 - d. External mounting lugs.
 - e. Drilled and tapped conduit holes.
 - f. Boxes where conduits enter a building below grade shall have 1/4-inch drain hole.
 2. Manufacturer: Provide pull and junction boxes of one of the following:

- a. Appleton Electric Company.
 - b. O-Z/Gedney Company.
 - c. Or equal.
3. Large boxes not generally available in cast construction may be fabricated of copper-free aluminum alloy or stainless steel code gage sheet metal.
 4. Boxes for installation in areas classified as hazardous locations shall be explosion proof and shall comply with UL 886.
 5. For flush-mounted pullboxes in slabs or pavement, provide vehicular traffic-bearing covers where indicated on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Mount boxes so that sufficient access and working space is provided.
- B. Securely fasten boxes to walls, other structural surfaces or slabs on or in which they are mounted. Provide independent galvanized steel supports where no walls or other structural surface exists.
- C. Install pull boxes in runs containing more than three 90 degree bends, runs exceeding 200 feet, where indicated on the Drawings and where required to conform with the National Electrical Code.
- D. Where sizes are not indicated, size junction and pull boxes in accordance with the requirements of the National Electrical Code.
- E. Provide terminal blocks in junction boxes where cable terminations or splices are required.

++ END OF SECTION ++

SECTION 16133

RECEPTACLES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install receptacles.
- B. Related Sections:
 - 1. Section 16130, Conduit Bodies and Outlet Boxes.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
 - 1. National Electrical Code.
 - 2. UL Standard No. 1010, Electrical Receptacle - Plug Combinations for Use in Hazardous Locations.

1.3 SUBMITTALS

- A. Shop Drawings: Submit for approval the following:
 - 1. Manufacturer's technical information for receptacles proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Receptacles for Non-Hazardous Locations:
 - 1. Duplex grounding receptacle, two pole, three wire, 125 volt AC, 20 ampere, with stainless steel cover plate unless otherwise shown or specified.
 - a. Product and Manufacturer: Provide one of the following:
 - 1) Cat. No. 5362, for dry indoor locations and Cat. No. 53CM62, for wet and corrosive locations, by Harvey Hubbell Incorporated.
 - 2) Cat. No. 5362, for dry indoor locations and Cat. No. 5362-CR, for wet and corrosive locations, by Arrow-Hart Incorporated.
 - 3) Or equal.

2. Duplex grounding receptacle, two pole, three wire, 250 volt AC, 20 ampere, with stainless steel cover plate unless otherwise shown or specified, NEMA G-20R.
 - a. Product and Manufacturer: Provide one of the following:
 - 1) Cat. No. HBL5462 by Harvey Hubbell Incorporated.
 - 2) Cat. No. 5462 by Arrow-Hart Incorporated.
 - 3) Or equal.
 3. Single receptacle, three pole, three wire, 125/250 volt AC, 50 ampere, with stainless steel cover plate unless otherwise shown or specified, NEMA 10-50 R.
 - a. Product and Manufacturer: Provide one of the following:
 - 1) Cat. No. HBL7962 by Harvey Hubbell Incorporated.
 - 2) Cat. No. 7985N by Arrow-Hart Incorporated.
 - 3) Or equal.
- B. Ground Fault Receptacles:
1. Duplex receptacle, two pole, three wire, 125 volt AC, 20 ampere with cover plate that conforms to Section 16130.
 2. Product and Manufacturer: Provide one of the following:
 - a. Cat. No. GF5362, by Harvey Hubbell Incorporated.
 - b. Cat. No. GF5342, by Arrow-Hart Incorporated.
 3. Install where shown on Drawings.
- C. Power Receptacles: 480 volt interlocked receptacle with enclosed safety switch service outlet: Provide service outlets, quantity as indicated on the Drawings for a welding receptacle.
1. Material: Copper free aluminum enclosure with operating handle NEMA 4, with gasketed hinged door.
 2. Switch: Heavy duty, 3 pole, with visible blades, a quick make a break mechanism with reinforced, positive pressure type blade and fuse clips. Switch shall be mechanically interlocked with the receptacle. The switch cannot be closed until the plug is fully inserted and the plug cannot be withdrawn or inserted unless the switch is open.
 3. Receptacle: Single ground receptacle, 3 wire, 4 pole, 600 volt, 60 amp. Provide two matching plugs.
 - a. Type WSR, and Type APS plugs by Crouse-Hinds Company.
 - b. Or equal.
- D. Power and Special Receptacles: Provide receptacles with number of poles and voltage and current rating as shown on the Drawings. Coordinate with equipment plugs. Provide matching plug for each receptacle.
- E. Provide weatherproof-while-in-use cover for all outdoor receptacles and where shown elsewhere on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install receptacles at locations indicated on the Drawings in outlet or device boxes in accordance with Section 16130, Outlet Boxes, in non-hazardous locations.
- B. Install receptacles in rigid metallic conduit systems in hazardous locations.
- C. Install receptacles with ground pole in the down position.
- D. Mount receptacles 18 inches above finished floor in non-hazardous locations and 4 feet above finished floor in hazardous locations unless otherwise noted.
- E. Install in conformance with National Electrical Code.

++ END OF SECTION ++



SECTION 16141

SNAP SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install snap switches for lighting control, at each field instrument which requires 120VAC, and other systems as shown on the Drawings.
- B. Related Sections:
 - 1. Section 16130, Conduit Bodies and Outlet Boxes.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
 - 1. National Electrical Code.
 - 2. UL Standard #20, General Use Snap Switches.

1.3 SUBMITTALS

- A. Shop Drawings: Submit for approval the following:
 - 1. Manufacturer's technical information for switches proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Switches for Non-Hazardous Locations:
 - 1. Single pole AC toggle switch, quiet type, 120/277 volt AC, 30 ampere, Ivory, specification grade.
 - a. Product and Manufacturer: Provide one of the following:
 - 1) Cat. #1221-I, by Harvey Hubbell Incorporated.
 - 2) Cat. #1991-I, by Arrow-Hart Incorporated.
 - 3) Or equal.

2. Single pole, 3-way AC toggle switch, quiet type, 120/277 volt AC, 30 ampere, Ivory, specification grade.
 - a. Product and Manufacturer: Provide one of the following:
 - 1) Cat. #1223-I, by Harvey Hubbell Incorporated.
 - 2) Cat. #1993-I, by Arrow-Hart Incorporated.
 - 3) Or equal.
 3. Two pole AC toggle switch, quiet type, 120/277 volt AC, 30 ampere, Ivory, specification grade.
 - a. Product and Manufacturer: Provide one of the following:
 - 1) Cat. #1222-I, by Harvey Hubbell Incorporated.
 - 2) Cat. #1992-I, by Arrow-Hart Incorporated.
 - 3) Or equal.
- B. Switch Covers:
1. See specification 16130, Outlet Boxes.
- C. Key Operated On-Off Switches:
1. Key operated switches shall be complete with legend plate, NEMA 4 enclosure and 2 keys.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install wiring devices in outlet or device boxes in accordance with Section 16130, Outlet Boxes, in non-hazardous locations.
- B. Mount wall switches in conformance with the Americans with Disabilities Act unless otherwise noted.
- C. Install switches in conformance with National Electrical Code.

++ END OF SECTION ++

SECTION 16390
GROUNDING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install complete grounding for the electrical systems. A green grounding conductor shall be installed in all conduits (except for conduits containing only analog or other special signal wiring). A grounding system, as substantially indicated on the Drawings, consisting of grounding rings; ground rods, underfooter grounds, metallic water pipe grounds, building steel column connections, etc shall be furnished and installed and shall be electrically connected.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
1. NEC Article 250, Grounding.
 2. UL Standard #467, Electrical Grounding and Bonding Equipment.

1.3 SUBMITTALS

- A. Shop Drawings: Submit for approval the following:
1. Manufacturer's technical information for grounding materials proposed for use.
 2. Listing of grounding connector types identifying where they are to be used.
 3. Layouts of each structure ground grid.
 4. Test point construction details.
 5. Results of ground resistance tests at each test point.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Bare Ground Cable:
1. Material: Annealed, bare, stranded tin plated copper, No. 4/0 AWG minimum size or as otherwise indicated on the DRAWINGS.
 2. Manufacturer: Provide ground cable of one of the following:
 - a. Cablec Corporation.
 - b. General Cable Corporation.

- c. Rome Cable Company.
- d. Or equal.

B. Ground Rods:

- 1. Material: Copperclad rigid steel rods, 3/4-inch diameter, 10 feet long.
- 2. Manufacturer: Provide ground rods of by one of the following:
 - a. Copperweld, Bimetallics Division.
 - b. ITT Blackburn Company.
 - c. Or equal.

C. Grounding Connectors:

- 1. Material: Pressure connectors shall be copper alloy castings, designed specifically for the items to be connected, and assembled with Durium or silicone bronze bolts, nuts and washers. Welded connections shall be by exothermic process utilizing molds, cartridges and hardware designed specifically for the connection to be made.
- 2. Product and Manufacturer: Provide grounding connectors of one of the following:
 - a. Pressure Connectors:
 - 1) O.Z./Gedney, Division of General Signal Corporation.
 - 2) Burndy Corporation.
 - 3) Or equal.
 - b. Welded Connections:
 - 1) Cadweld by Erico Products, Incorporated.
 - 2) Therm-O-Weld by Burndy Corporation.
 - 3) Or equal.

PART 3 - EXECUTION

3.1 STRUCTURE GROUND SYSTEM

- A. Provide #4/O bare tin plated copper ground grids with ground rods around all buildings, meter vaults and equipment pads minimum 2 feet-6 inches below grade, and connect the grids to each other via the underground ductbank grounding conductor.
- B. Install ground rods where shown on the DRAWINGS. Install additional ground rods if necessary to attain a resistance to ground of less than 5 ohms for each ground grid.
- C. For structures with steel columns, install #2 ground cable from grid to each column around the perimeter of the structure. Connect cable to steel using exothermic welds.

- D. Connect grids to a continuous underground water pipe system when practical.
- E. Provide accessible test points for measuring the ground resistance of each grid.
- F. Weld all buried connections, except for test points.

3.2 EQUIPMENT GROUNDING

- A. Ground all electrical equipment, motors, control panels, handrails and process equipment, etc in compliance with the National Electrical Code.
- B. Ground fences with #4 bare tinned copper conductors using clamps specifically intended for this use at not less than ten foot intervals.
- C. Equipment grounding conductors shall be insulated stranded copper cable of adequate size installed in metal conduit where necessary for mechanical protection.
- D. Connect ground conductors to conduit with copper clamps, straps or with grounding bushings.
- E. Connect to piping by welding or brazing. Use copper bonding jumpers on all gasketed joints.
- F. Connect to equipment by means of lug compressed on cable end. Bolt lug to equipment frame using holes or terminals provided on equipment specifically for grounding. Do not use hold down bolts. Where grounding provisions are not included, drill suitable holes in locations designated by ENGINEER.
- G. Connect to motors by bolting directly to motor frames, not to sole plates or supporting structures.
- H. Connect to service water piping by means of copper clamps. Use copper bonding jumpers on all gasketed joints.
- I. Scrape bolted surfaces clean and coat with a conductive oxide- resistant compound.
- J. Liquid tight flexible metal conduit in all sizes shall be equipped with external bonding jumpers, in addition to the equipment ground installed with the circuit conductors. Use liquid tight connectors integrally equipped with suitable grounding lugs.
- K. Where conduits enter into equipment free of the metal enclosure, install grounding bushing on each conduit and bond bushing lug to equipment ground bus.

- L. Where conduits enter equipment enclosures, equip each penetration inside with grounding bushing. Install bonding jumper from each grounding bushing to ground bus.
- M. Equipment enclosures that do not come furnished with a ground bus, install ground lug in each enclosure that shall be bonded to the metal cabinet or backpan of the enclosure.
- N. Separately derived systems shall be each grounded as shown and shall comply with Article 250 of the NEC except where higher standards are shown.

3.3 TESTING

- A. Test the completed ground systems for continuity and for resistance to ground using an electrical ground resistance tester. Document the results and submit to the ENGINEER.
- B. The OWNER shall be present during all testing.

++ END OF SECTION ++

SECTION 16440

DISCONNECT SWITCHES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install disconnect switches.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
1. National Electrical Code.
 2. UL #98, Enclosed Switches.
 3. NEMA KS-1, Enclosed Switches.

1.3 SUBMITTALS

- A. Show Drawings: Submit for approval the following:
1. Manufacturer's technical information for disconnect switches proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Single Throw, Circuit Disconnect Switches:
1. Type: Fused or unfused, horsepower rated, heavy-duty, single-throw, quick-make, quick-break mechanism, visible blades in the OFF position and safety handle.
 2. Rating: 600 volts, with number of poles and ampere rating as required for motor or equipment circuits being disconnected. Switches shall bear a UL label.
 3. Where fused switches are required, furnish and install fuses as recommended by the manufacturer of the equipment being served.

B. Double Throw Safety Switches:

1. Type: Unfused, double throw with center OFF position, quick-make, quick-break mechanism visible blades in the OFF position and safety handle.
2. Rating: 600 volts, with number of poles and ampere rating as required by the Drawings for the circuits being disconnected.
3. This type of switch may be referred to as a “manual transfer switch” on the Drawing.

C. Enclosure:

1. NEMA 12 for dry, indoor non-corrosive areas.
2. NEMA 4X 316 stainless steel for wet or corrosive locations.
3. Nameplate identifying equipment for which switches serve as the disconnecting means.

D. Manufacturer: Provide disconnect switches of one of the following:

1. Cutler-Hammer/Eaton.
2. General Electric Company.
3. Or equal.

E. Electric Interlock Kit:

1. Provide electrical interlock kit. Interlock kit shall contain auxiliary dry contacts that emulate the switch position. Auxiliary contacts shall break control circuit before the main switch breaks.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Mount equipment so that sufficient access and working space is provided for ready and safe operation and maintenance. Maintain clearance's per NEC Article 110.26
- B. Securely fasten equipment to walls, handrails, or other structural supports on which they are mounted. Provide independent 316 stainless steel supports where no wall or other structural surface exists.
- C. Furnish one set of spare fuses for each fused disconnect switch to be installed.
- D. Install in conformance with National Electrical Code.

++END OF SECTION++

SECTION 16470

LIGHTING AND DISTRIBUTION PANELBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install lighting and distribution panelboards.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
1. NEC Article 408, Switchboards and Panelboards.
 2. UL Standard #50, Electrical Cabinets and Boxes.
 3. UL Standard #67, Electric Panelboards.
 4. NEMA PB1, Panelboards.

1.3 SUBMITTALS

- A. Shop Drawings: Submit for approval the following:
1. Manufacturer's technical information for panelboards and circuit breakers proposed for use.
 2. Listing of the panelboards to be furnished with their proposed location and number of branch circuit breakers identified.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Panelboards:
1. Rating: Voltage rating, current rating, number of phases, number of wires and number of poles shall be as indicated on the Drawings.
 2. Circuit Breakers: Molded case, bolt-in thermal magnetic type with number of poles and trip ratings as shown on the Drawings.

3. Main and branch circuit breakers shall be fully rated with interrupting capacities as follows:
 - a. 65,000 amps for 480/277 volt circuit breakers.
 - b. 22,000 amps for 208/120 volt circuit breakers.
 4. Bus Bars: 98 percent conductivity copper, tin plated. All 4 wire panelboards shall have a solid neutral bar. All panels shall have ground bus.
 5. Main: All panelboards shall have a main circuit breaker unless Drawings specifically call for main lugs only.
 6. Branch circuit breakers connected for sequence phasing.
 7. Construction: Code grade steel, NEMA 12, ample gutter space, flush door, flush snaplatch and lock for dry locations, NEMA 4X 316 stainless steel for wet or corrosive locations, unless indicated otherwise on the Drawings.
 8. Trim: Surface or flush as required.
 9. Directory: Typed card, with glass cover in frame on back of door giving the circuit numbers and the area or equipment served.
 10. Identification: Nameplate identifying the panel number and voltage.
 11. Panelboards installed inside of motor control centers shall be of the same manufacturer as the motor control center.
 12. Provide a wireway (NEMA 12 or NEMA 4X as applicable) under each panelboard to accommodate the incoming conduits from the field. Provide oversized conduit "nipples" from the wireway to the panelboard for routing of the cables into the panelboard.
 13. All 480V circuit breakers shall be provided with a padlock attachment to lock the breaker in the "open" position. Panelboard door shall be closable with padlock in place.
 14. Manufacturer: Provide panelboards of one of the following:
 - a. Cutler-Hammer/Westinghouse.
 - b. General Electric.
 - c. Or equal.
- B. Mini-Power Centers:
1. General: Mini-power center shall consist of an encapsulated dry-type transformer, primary and secondary main circuit breakers, and secondary panelboard all in one enclosure.
 2. Transformer Rating: KVA, primary voltage, secondary voltage, frequency and number of phases shall be as shown on the Drawings.
 3. Branch Circuits: Molded case circuit breakers, plug-in thermal magnetic type with number of poles and trip ratings as shown on the Drawings.
 4. Enclosure: Weatherproof, NEMA 4X 316 stainless steel.

5. Product and Manufacturer: Provide mini-power centers of one of the following:
 - a. Cutler-Hammer/Westinghouse.
 - b. General Electric.
 - c. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Mounting: Install panelboards at locations shown on Drawings. Set cabinets so that top circuit breaker is not over 6 feet from the floor.
- B. Directory: Complete typewritten directory indicating items controlled by each circuit breaker.
- C. Directory shall be water resistant.

++ END OF SECTION ++



Handwritten mark or signature.