

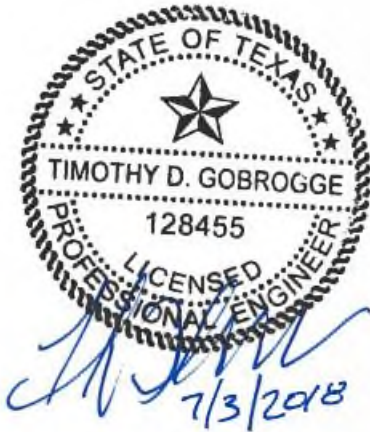


Pre-Purchase of Medium Voltage Metal Clad Switchgear
for the
Central Water Integration Pipeline Project

SAWS Job No. 18-8616
Solicitation No. 18- 18099

RELEASED FOR BID
JULY 2018

DIVISIONS 16



Tetra Tech, Inc.
Texas Registered Engineering Firm No. 3924
700 North Saint Mary's Street, Suite 300
San Antonio, Texas 78205



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DIVISION 1



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DIVISION 16

ELECTRICAL

SECTION 16345
MEDIUM VOLTAGE METAL-CLAD SWITCHGEAR

PART 1 GENERAL

1.01 SCOPE OF WORK:

- A. This specification describes a complete assembly to be furnished by a single Switchgear Manufacturer (Manufacturer) for installation by Others (Contractor).
- B. The Manufacturer shall furnish and install assemblies of medium voltage metal-clad switchgear, together with appurtenances, complete and operable, as specified herein and as shown on the Contract Drawings.
- C. The Manufacturer shall coordinate with the Contractor for Protective Relay settings as determined in the Power System Study as performed under a different Contract. The Contractor shall be responsible for performing the study for the Plant system under a different Contract.

1.02 RELATED WORK: (NOT USED)

1.03 SUBMITTALS:

- A. Pre-Purchase Contract Schedule: It is anticipated that this pre-purchase contract will follow the approximate schedule below:
 - 1. Submittals-Preliminary: (with the bid)
 - 2. Submittals: September 14, 2018
- B. The Manufacturer shall provide the following with the bid:
 - 1. Equipment outline drawings showing elevation and plan views, dimensions, weight, shipping splits and metering layouts. Indicate all options, special features, ratings and deviations from the Specifications.
 - 2. Bus arrangement drawings.
- C. The Manufacturer shall provide the following with Submittals (September 14, 2018)
 - 1. Equipment outline drawings showing elevation and plan views, dimensions, weight, shipping splits and metering layouts. Indicate all options, special features, ratings and deviations from the Specifications.
 - 2. Bus arrangement drawings.
 - 3. Product data sheets and catalog numbers for overcurrent protective trip devices on circuit breakers and switches, relaying, meters, pilot lights, etc. The manufacturer's name shall be clearly visible on the each cut sheet submitted. List all options, trip adjustments and accessories furnished specifically for this project. Clearly mark each sheet to indicate which items apply and/or those items that do not apply.
 - 4. Provide control systems engineering to produce custom unit elementary

drawings showing interwiring and interlocking between components and to remotely mounted devices. Include and identify all connecting equipment and remote devices on the schematics. The notation "Remote Device" will not be acceptable. Show wire and terminal numbers. Indicate special identifications for electrical devices per the Drawings.

5. Provide plan and elevation drawings of each controller or enclosure, with dimensions, exterior and interior views, showing component layouts, controls, terminal blocks, etc.
 6. Schematic diagram
 7. Nameplate schedule
 8. UL Listing of the completed assembly.
 9. Component list with detailed component information, including original manufacturer's part number.
 10. Conduit entry/exit locations
 11. Assembly ratings including:
 12. Short-circuit rating
 13. Voltage
 14. Continuous current
 15. Major component ratings including:
 16. Voltage
 17. Continuous current
 18. Interrupting ratings
 19. Number and size of cables per phase, neutral if present, ground and all cable terminal sizes.
 20. Key interlock scheme drawing and detailed written sequence of operations
 21. Connection detail between close-coupled assemblies
 22. Composite floor plan of close-coupled assemblies
 23. Instruction and renewal parts books.
- D. The Manufacturer shall submit the following under the Contractor's scope of supply and not with the Pre-Purchased Contract:
1. Operations and Maintenance Manual as specified in Section 01730 and herein.
 2. Protective Relay Settings.
 3. Delivery, storage, and handling instructions.
 4. Factory Tests. Submittals shall be made for factory tests as specified herein.
 5. Field Test Reports. Submittals shall be made for field tests specified herein.

- E. Submittals shall be made in accordance with the requirements of Section 01300 and as specified herein.
- F. Submittals shall also contain information on related equipment to be furnished under this Specification. Incomplete submittals not containing the required information on the related equipment will also be returned unreviewed.
- G. The Manufacturer shall create all equipment shop drawings, including all wiring diagrams, in the Manufacturer's Engineering department. All equipment shop drawings shall bear the Manufacturer's logo, drawing file numbers, and shall be maintained on file in the original equipment manufacturer's archive file system. Photocopies of the Engineer's ladder schematics are unacceptable as shop drawings.
- H. Operation and Maintenance Manuals.
 - 1. Operation and maintenance manuals shall include the following information:
 - a. Manufacturer's contact address and telephone number for parts and service.
 - b. Instruction books and/or leaflets
 - c. Recommended renewal parts list
 - d. Record Documents for the information required by the Submittals paragraph above.
 - e. Certified copies of factory test reports.

1.04 REFERENCE CODES AND STANDARDS:

- A. The medium voltage pad mounted switchgear and protection devices in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
 - 1. ANSI C37.06-2000, Switchgear - AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities
 - 2. ANSI/IEEE C37.04 and C 37.06, Standard ratings and Preferred Ratings for Indoor AC Medium-Voltage Circuit Breakers used in Metal-Clad Switchgear
 - 3. ANSI / IEEE C37.09, Standard Design and Production Testing
 - 4. ANSI/IEEE C37.20.2, Standard for Metal-Clad Switchgear
 - 5. ANSI/IEEE C37.11, Requirements for Electrical Control for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis or Total Current Basis
 - 6. ANSI/IEEE C57.13, Standard Requirements for Instrument Transformers.

7. ANSI / Z55.1, Gray Finishes for Industrial Apparatus and Equipment
8. NEMA SG 2, High Voltage Fuses
9. NEMA SG 4, Alternating - Current High Voltage Circuit Breaker
10. NEMA SG 5, Power Switchgear Assemblies
11. International Electrochemical Commission (IEC)
12. IEC 56, High Voltage Alternating Current Circuit Breakers

1.05 QUALITY ASSURANCE:

- A. The Manufacturer shall have produced similar equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- B. The Manufacturer of the assembly shall be the Manufacturer of the major components within the assembly. All assemblies shall be of the same Manufacturer. Equipment that is manufactured by a third party and “brand labeled” shall not be acceptable.
- C. All components and material shall be new and of the latest field proven design and in current production. Obsolete components or components scheduled for immediate discontinuation shall not be used.
- D. Equipment submitted shall fit within the space shown on the Drawings. Equipment which does not fit within the space is not acceptable.
- E. For the equipment specified herein, the Manufacturer shall be ISO 9001 2000 certified.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. The Manufacturer shall provide unloading, storage, and handling instructions prior to shipment.
- B. All equipment shall be delivered in good, sound condition, and free from damage. Equipment which has been damaged will be rejected.
- C. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Breakers and accessories shall be packaged and shipped separately.
- D. Switchgear shall be equipped to be handled by crane. Where cranes are not available, switchgear shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.

- E. The Contractor shall be responsible for proper unloading, handling, and storage of equipment in accordance with the Manufacturer's instructions.
- F. Where space heaters are provided in equipment, provide temporary electrical power and operate space heaters, during jobsite storage and after the equipment is installed in permanent location, until equipment is placed in service.

1.07 WARRANTY:

- A. The Manufacturer's warranty period shall be concurrent with Contractor's for two (2) years, commencing at the time of final acceptance by the Owner which shall begin no later than April 15, 2020. Guarantee shall cover all necessary labor, equipment, materials and replacement parts resulting from faulty or inadequate equipment design, improper assembly, defective workmanship and materials, breakage or other failure of all equipment and components furnished by the Manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS:

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - 1. Eaton Cutler-Hammer
 - 2. Siemens
 - 3. Schneider Electric Square D
 - 4. General Electric Co.
- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.2 RATINGS – SWITCHGEAR:

- A. The switchgear described in this specification shall be designed for operation on the voltage systems as shown on the Drawings. Each circuit breaker shall have the following ratings:
 - 1. Maximum Voltage: 5KV
 - 2. BIL Rated: 60kV
 - 3. Continuous Current: As shown
 - 4. Short-Circuit Current, At Rated Maximum kV: 31.5kA

5. Closing and Latching Capability: 82kA Peak
6. Rated Interrupting Time: Three cycles

2.3 CONSTRUCTION – SWITCHGEAR:

A. General

1. The switchgear described in this specification shall contain factory assembled and operational tested circuit breakers and accessories and be self-supporting in a manner to be installed on a level concrete pad.
2. Refer to Drawings for actual layout and location of equipment and components; current ratings of devices, bus bars, components; protective relays, voltage ratings of devices, components and assemblies; and other required details.
3. Where the equipment contains an uninterruptible power supply (UPS), the Manufacturer shall furnish factory installed, a dedicated Point of Utilization Device (SPD), as specified herein.
4. Nameplates
 - a. External
 - 1) Furnish nameplates for each device as specified herein and as indicated on the Drawings. All nameplates shall be laminated plastic, black lettering on a white background, attached with stainless steel screws. There shall be a master nameplate that indicates equipment ratings, manufacturer's name, shop order number and general information. Cubicle nameplates shall be mounted on the front face, on the rear panel and inside the assembly, visible when the rear panel is removed.
 - b. Internal
 - 1) 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.
 - c. Special
 - 1) Identification nameplates shall be white with black letters, caution nameplates shall be yellow with black letters, and warning nameplates shall be red with white letters.
5. Control Devices and Indicators

- a. All operating control devices, indicators, and instruments shall be securely mounted on the panel door. All controls and indicators shall be 30mm, corrosion resistant, reinforced plastic, NEMA 4/4X/13. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical and electrical equipment requirements.
- b. Indicator lamps shall be LED type. Unless otherwise shown on the Drawings, lens color shall be green for De-energized, red for Energized and amber for FAIL or ALARM. For all control applications, indicator lamps shall incorporate a push-to-test feature.
- c. Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, etc) shall be as shown on the Drawings. Units shall have the number of positions and contact arrangements, as required. Each switch shall have an extra dry contact for remote monitoring.
- d. Pistol grip switches shall be provided for CLOSE and TRIP operation of the circuit breakers, with momentary or maintained contacts as required by the Drawings.
- e. Furnish nameplates for each device. All nameplates shall be laminated plastic, black lettering on a white background, attached with stainless steel screws. Device mounted nameplates are not acceptable.
- f. The manufacturer shall not remove, reuse, alter, or replace original equipment nameplates or equipment tags associated with equipment or components supplied by the manufacturer's suppliers and sub-suppliers.

6. Voltage Transformers

- a. Voltage transformers shall be draw out type, with current-limiting fuses and with BIL rating equal to the switchgear. Transformers shall be as shown on the Drawings.
- b. For rigidity during fault conditions all connections to roll-out potential transformer trays and control power transformer trays shall be rigid bus bars insulated to full voltage rating of switchgear assembly.

7. Current Transformers

Current transformers shall be furnished as indicated on the contract drawings. The thermal and mechanical ratings of the current transformers shall be coordinated with the circuit breakers. Their accuracy rating shall be equal to or higher than ANSI standard requirements. The standard location for the current transformers on the bus side and line side of the breaker units shall be front accessible to permit adding or changing current transformers without removing high-

voltage insulation connections. Shorting terminal blocks shall be furnished on the secondary of all the current transformers.

8. Control Power Transformers

- a. Control power transformers shall be as shown on the Drawings. Transformer mechanical ratings shall equal the BIL and momentary rating of the circuit breakers. Transformers, when mounted in switchgear assemblies, shall be rated for the full voltage of the switchgear.
- b. All control power transformers shall have vacuum cast primary and secondary coils using epoxy resin. Voltage and control power transformers of the quantity and ratings indicated. Voltage transformers shall be mounted in drawout drawers contained in an enclosed auxiliary compartment. The voltage transformer primary connections shall utilize epoxy insulated bus bar. Rails shall be provided for each drawer to permit easy inspection, testing and fuse replacement. Shutters or barriers shall isolate primary bus stabs when drawers are withdrawn. A mechanical interlock shall be provided to require the secondary breaker to be open before the CPT drawer or CPT primary fuse drawer can be withdrawn.

9. Instrument Transformers

- a. All instrument transformers shall be metering accuracy type and vacuum cast using polyurethane resin.
- b. Transformers shall be as shown on the Drawings. Transformer mechanical ratings shall equal the BIL and momentary rating of the circuit breakers. Transformers, when mounted in switchgear assemblies, shall be rated for the full voltage of the switchgear.
- c. Secondary control wiring shall be No. 14, extra flexible, stranded, tin-plated copper control wire, Type SIS cross-linked polyethylene, rated 600 volts, except for specific circuits requiring larger wire. Crimp-type, uninsulated spade terminals shall be furnished on all wire ends, except where non-insulated ring terminals are used to connect to fuse blocks, and instrument transformer studs. Secondary control wires shall be armored where they pass through primary compartments.
- d. For rigidity during fault conditions all connections to roll-out potential transformer trays and control power transformer trays shall be rigid bus bars insulated to full voltage rating of switchgear assembly.
- e. Voltage transformers shall be draw out type, with current-limiting fuses and with BIL rating equal to the switchgear. Transformers shall be as shown on the Drawings.

B. Enclosures

1. Enclosures shall be NEMA 3R Protected Aisle Walk-in with lighted interior aisle of adequate width to permit routine servicing operations for switchgear protective devices. Housing shall have two (2) lockable entrance doors with lock-defeating panic hardware and thermostatically controlled ventilation fan. The enclosure shall be extended on the breaker drawout side to form an operating and/or maintenance aisle large enough to permit interchange of circuit breakers. Interior lights, light switches, and duplex ground fault receptacles shall be furnished and factory installed in the aisle.
2. Each vertical section shall be provided with heavy duty, 240 VAC space heaters, thermostat controlled, of sufficient size to prevent condensation with the equipment de-energized. Heaters shall operate at half voltage for extended life. Power for space heaters shall be furnished from a control transformer mounted in the switchgear.
3. Enclosures shall be freestanding, metal clad medium voltage switchgear assemblies, consisting of dead front, completely metal enclosed vertical sections. In each unit, major primary circuit parts (breaker, buses and transformers) shall be completely enclosed by grounded metal barriers, including a front barrier as part of the circuit breaker. Two rear covers shall be furnished for each vertical section for circuit isolation and ease of handling. Refer to drawings for any size limitations.
4. In each section provide IR viewing window for each termination.

C. Finish

1. All steel structure members shall be cleaned, rinsed, and phosphatized prior to painting.
2. The switchgear shall be painted with an electrostatically applied polyester powder with final baked on average thickness between 1.5 and 2.0 mils and meet ANSI requirements for indoor equipment.
3. All exterior surfaces of the switchgear assembly shall be given final finish coats of ANSI 61 gray as standard.
4. Finish shall have a minimum pencil hardness of 2H as tested per ASTM D3363 and shall pass the ASTM B117 Salt spray test for a minimum of 500 hours.

D. Busses and Bus Supports

1. Busses shall be silver-plated copper and rated as shown on the Drawings. Bus bars shall have a continuous current rating, as shown on the Drawings, based on temperature rise and documented by design tests. All joints shall be tin plated with at least 2 bolts per joint. The switchgear shall be constructed so that all buses, bus supports and connections shall withstand stresses that would be produced by currents equal to the momentary ratings of the circuit breakers. Busses shall have provisions for future extension. All bus joints shall be plated, bolted and insulated with easily installed boots. The bus shall be braced to withstand fault currents equal to the close and latch rating of the breakers. Bus and bus bars shall have fluidized-bed epoxy flame retardant and non-

hydroscopic insulation.

E. Ground Bus

1. A tin-plated ground bus (1/4 by 2-inch copper) shall extend throughout assembly with connections to each breaker grounding contact and cable compartment ground terminal. Station ground connection points shall be located in each end section.

F. External Wiring Connections

1. Preparation for the incoming and outgoing cables, to be connected to the switchgear, the lugs, terminators, etc., shall be as specified herein.
 - a. For Power and Control conductors up to 1000V, all lugs and connectors shall be copper and shall be crimped type, with standard industry tooling. Lugs and connectors shall match the wire size where used, and shall be clearly identified and color coded on the connector. All connections shall be made for stranded wire and shall be made electrically and mechanically secured. The lugs and connectors shall have a current carrying capacity equal to the conductors for which they are rated and meet UL 486 requirements for 75 degrees C. Lugs larger than 4/0 AWG shall be two-hole lugs with NEMA spacing. The lugs shall be of closed end construction to exclude moisture migration into the cable conductor.
 - b. For Medium Voltage power conductors, copper lugs and connectors shall be crimped with standard industry tooling, and made electrically and mechanically secure. The lugs and connectors shall have a current carrying capacity equal to the conductors for which they are rated and meet UL 486 requirements for 75 degrees C. Lugs larger than 4/0 AWG shall be two-hole lugs with NEMA spacing. The lugs and connectors shall be rated for operation through 35 kV. The lugs shall be of closed end construction to exclude moisture migration into the cable conductor.

G. Lightning Arrestors and Surge Capacitors

1. Where shown on the Drawings, station class lightning arrestors and surge capacitors shall be provided in the incoming sections.

H. Wiring/Terminations

1. The Manufacturer shall provide suitable terminal blocks for secondary wire terminations and a minimum of 10% spare terminal connections shall be provided. One control circuit cutout device shall be provided in each circuit breaker housing. Switchgear secondary control wire shall be (minimum) #14 AWG (#12 for CT circuits) type SIS, 41 strand extra flexible, stranded tin-plated copper or larger rated 600-volt, 90 degrees C, furnished with wire markers at each termination. All control wiring shall be UL listed and have a VW-1 flame retardant rating. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams.
2. Exposed wiring shall be suitably protected against contact with sharp edges.

Throughout the assembly it shall be neatly bundled and secured with nylon wire ties. Where control wiring passes from cubicle to door, it shall be wrapped with suitable protection to prevent damage. Holes, cut to allow control wires to pass from cubicle to cubicle, shall have a grommet for protection.

3. Each control wire shall be marked at both terminations to agree with wiring diagrams. Plastic wire markers of either the slip on or heat shrink variety shall be provided.
4. Incoming line and feeder cable lugs of the type and size indicated elsewhere shall be furnished.

I Circuit Breakers

1. The circuit breakers shall be horizontal draw out type, capable of being withdrawn on rails. The breakers shall be operated by a motor-charged stored energy spring mechanism, charged normally by a universal electric motor and in an emergency by a manual handle. The primary disconnecting contacts shall be silver-plated copper.
2. Each circuit breaker shall contain three vacuum interrupters separately mounted in a self-contained, self-aligning pole unit, which can be removed easily. The vacuum interrupter pole unit shall be mounted on glass polyester supports for 5 KV class. Provision shall be made for checking contact wear gap on each vacuum interrupter, visible when the breaker is removed from its compartment. The current transfer from the vacuum interrupter moving stem to the breaker main conductor shall be a non-sliding design. The breaker front panel shall be removable when the breaker is withdrawn for ease of inspection and maintenance.
3. Circuit breaker compartments shall be designed to house removable-element circuit breakers. Stationary primary disconnect contacts shall be silver-plated copper. Grounded metal safety shutters shall isolate all primary connections in compartment when breaker is withdrawn from connected position.
4. Circuit breakers shall be rated as indicated in drawings. Circuit breakers of equal rating shall be interchangeable. Circuit breakers shall be operated by an electrically charged, mechanically and electrically trip-free, stored-energy spring. A handle shall be used to manually charge the spring for slow closing of contacts for inspection or adjustment.
5. Circuit breakers shall be equipped with secondary disconnecting contacts which shall automatically engage in the connected position.
6. Each breaker compartment with breaker shall be designed to permit remote racking of the breaker between the connected and disconnected positions. The compartment design shall permit a control box to be connected to the operator with a minimum thirty-foot cable, permitting control from a remote location. The operator attachment method shall provide for racking of the breaker when the compartment door is fully closed. The remote racking operator shall be portable with a 120 VAC power cord. It shall not be possible to install the remote racking operator when the breaker is closed and the breaker cannot be closed with the remote racking operator in place.

7. An indicator shall show breaker position when racking breakers in or out of their connected positions
8. Interlocks shall prevent moving breaker to or from operating position unless main contacts are open. Operating springs shall be discharged automatically when breaker is rolled fully into connected or disconnected position. Rackout device shall have provisions to padlock in connected or disconnected position. When locked in disconnected position, breaker shall be removable from compartment using portable lifting device. Padlock shall not interfere with breaker operation.
9. Automatic shutters shall cover primary disconnect stabs when breaker is withdrawn to test/disconnect position. Shutters shall be positively driven by linkages connected to racking mechanism. A stationary barrier shall be located in front of the shutters for additional safety.
10. Breaker control voltage shall be 120 VAC. Breaker tripping power shall be provided from a 120V A-C capacitor trip unit Control power source shall be from the CPT auto throw over source as specified herein.
11. The breakers shall be electrically operated by the following control voltages: 120V close and trip

J. Circuit Breaker Control and Interlocking Functions

1. Control
 - a. Loss of normal service voltage as determined by the protective relaying on a main circuit breaker shall not cause that circuit breaker to trip open.
 - b. Close and trip circuits shall be separately fused. Fuse blocks shall be dead front, pull-out type.
 - c. Each breaker shall be complete with control switch and red and green indicating lights to indicate breaker contact position.
 - d. Each breaker shall have a minimum of 4 normally open and 4 normally closed spare auxiliary contacts wired to accessible terminal blocks.
 - e. Where a Control Power Auto Transfer System is shown on the Drawings, the system shall consist of a relay operated arrangement. Upon loss of the primary control power the system shall transfer to the secondary CPT. System shall revert upon resumption of the primary source.
2. Interlocking Functions
 - a. Key Interlock
 - 1) Where a main bus tie breaker is shown, the main bus tie breaker cannot be closed unless one of the main breakers is open. It shall not be possible to close both main circuit breakers with the main bus tie breaker closed. The key-interlock (two keys for three breakers) shall be provided.

- 2) Where Kirk-Key arrangements are used the Kirk keyed interlocks shall be Kirk HD Series (Heavy Duty) 316 Series of 316 stainless steel, or approved equal.

2.4 FEEDER PROTECTION SYSTEM - MAIN BREAKERS AND FEEDER BREAKERS:

- A. Furnish where shown on the Drawings, a Feeder Protection Relay, for feeder monitoring and protection, for each Main Breaker as shown on the Drawings, and as specified herein.
- B. Current and potential test blocks and plugs shall be provided for all metering and protection circuits.
- C. A 100VA minimum UPS shall be provided, powered from the control power transformer to provide control power to the feeder management relays and power quality meters. UPS battery shall be rated for 2 (two) hours minimum. The actual size of the UPS and batteries shall be determined by the manufacturer.
- D. Where Type 86 relay are specified or shown on the Drawings, the relay shall be a door mounted, high speed multicontact relay for trip and/or block close breaker control and contact multiplication. Contacts shall be electrically separate. Relay shall be electrical trip and manually reset. A black target shall indicate the Reset position and an orange target the Tripped position. Where the relay is shown as an output of a Main or Feeder Breaker Protective System, the Type 86 Relay functions may be incorporated into the associated Breaker Protective System, if the Protective System can provide all of the relay functions and capabilities specified above. The relay shall be a GE type HEA or approved equal.

2.5 METERING AND PROTECTIVE RELAYS:

- A. Feeder Protection System (FP1)
 1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - a. GE/Multilin Model 850.
 - b. Approved equal.
 2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
 3. General
 - a. Digital relay for management and primary protection of feeders, and management and backup protection of buses, transformers and transmission lines.
 - b. The unit shall provide protection, control, and monitoring functions with both local and remote human interfaces.
 - c. The relay shall be of drawout construction.

- d. All circuit boards shall have a harsh environment conformal coating to resist H₂S gas and other corrosive agents, including humidity.
- e. All components, except terminating hardware, shall be mounted inside the relay.
- f. The unit shall be suitable for semi-flush mounting in a panel.
- g. It shall be equipped with a front panel display and keypad for programming and monitoring.
- h. The relay shall comply with surge withstand capability standards ANSI C37.90 and IEC 255.4.

4. Protection

- a. The relay shall have the following protective functions:
 - 1) Time phase overcurrent elements for all phases with level detectors.
 - 2) The phase time overcurrent element shall be capable of dynamic adjustment of the pickup setting from manual close blocking, cold load pickup and voltage restrained overcurrent features;
- b. Time ground overcurrent elements with level detectors.
- c. Directional control of both phase and ground overcurrent elements.
- d. Two independent elements each for:
 - 1) Undervoltage
 - 2) Overvoltage
 - 3) Underfrequency

5. Control

- a. The relay shall be able to trip and close an associated circuit breaker and track the breaker position. The relay shall include a Red breaker closed LED.
- b. Closing operations shall be supervised by a synchro-check scheme, with voltage source level or manual override provisions.
- c. The relay shall be able to control the overcurrent elements in a cold load pickup or manual closing operating mode.
- d. The relay shall have a minimum of 14 programmable logic inputs for manual commands or feature control
 - 1) Inputs shall be able to operate from internal and external dc power supplies.

6. Metering

- a. The unit shall be able to measure / calculate and display:
 - 1) Line voltage
 - 2) Differentials between bus and line voltages

- 3) Frequency
 - 4) Current
 - 5) Real, reactive and apparent power
 - 6) Power factor
 - 7) Watt-hour and var hour consumption
 - 8) Demand for current and power measurements
- b. The relay shall have an input channel for measuring a 0-1 mA, 0-5 mA, 0-20 mA, or 4-20 mA (programmable) signal from an external transducer.
- c. The relay shall have eight internal transducers with 4-20 mA output signals to represent various measured / calculated parameters.
- 1) Output channels shall be programmable to represent, as a minimum:
 - Voltage
 - Frequency
 - Current
 - Power
 - Demand
 - The distance to the most recently detected overcurrent fault.

7. Monitoring

- a. The relay shall have measuring elements with programmable outputs to monitor:
- 1) Breaker trip and close coil continuity
 - 2) Over frequency
 - 3) Demand levels
 - 4) Power factor
 - 5) Summed breaker arcing current
- b. The relay shall be able to display automatically at least 10 user-programmed protection settings or measured / calculated parameters.

8. System/Relay Operations and Maintenance

- a. The relay shall have a sequence of events record and oscillographic capture of important events with a time base in 1 ms increments.
- 1) The event record shall store a minimum of 64 events.
 - 2) The oscillograph shall capture a minimum of eight events.
- b. The relay shall have a distance-to-fault feature that stores a minimum of

- eight faults.
- c. The relay shall have a simulation feature to test the device without external injection of voltage and current signals.
 - d. Device firmware shall be stored in non-volatile flash memory, so that relay upgrades can be performed by downloading programs from a PC.
9. Control Power - The relay shall be suitable for HI or LO ranges of available control power.
- a. HI Range: DC: 88-300 VDC; AC: 70-265 VAC, 48 to 62 Hz.
 - b. LO Range: DC: 20-60 VDC; AC: 20-48 VAC, 48 to 62 Hz.
10. Communication
- a. For remote monitoring, the following communication ports shall be provided:
 - 1) One (1) Industry Standard port for meter and relay programming using a laptop computer.
 - 2) One (1) RS-485 port.
 - 3) One (1) integral 10/100BaseT Ethernet port. The connection shall support Modbus TCP, Ethernet IP and SNMP. Where an integral port is not available, provide a media protocol converter as specified herein.
 - b. The protocol interface shall implement the following:
 - 1) All data shall be available and/or mirrored within the Modbus 4x or "Holding Register" memory area.
 - 2) Register 4x00001 shall exist and be readable to allow simple, predictable "comm tests".
 - c. The media protocol converter shall meet the following criteria:
 - 1) The converter shall support 10/100Base-T Ethernet. The serial port speed (baud rate) shall support 230kbps. The protocol shall support Modbus TCP, Ethernet IP, DF1, and Modbus RTU/ASCII. Protocol shall be Web Browser configurable.
 - 2) Operating limits shall be 0-60 degrees C, with humidity range minimum of 5-90 percent. Shock capability on the serial port shall be ESD +15 kV air GAP meeting IEC 1000-4-2. Power requirements shall be 9-30VDC at 0.5A minimum.
 - 3) The converter shall have LED status for serial, signals, power, and Ethernet.
 - 4) The converter housing shall be UL 1604, Class 1 Div 2, DIN Rail mountable. The converter shall have DB-9M port connection, with screw terminals, to the input.
 - 5) Converter shall be Digi One IAP, or approved equal.

B. Power Quality Meter (PM1)

1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - a. GE Multilin PQMII Power Quality Meter.
 - b. Approved Equal.
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
3. General
 - a. All circuit boards shall have a harsh environment conformal coating to resist H₂S gas and other corrosive agents, including humidity.
4. Monitoring and Metering
 - a. Metering Functions with accuracy of 0.2 percent for A & V and 0.4 percent for power parameters
 - 1) A, V, VA, W, VAR, KWH, KVARH, KVAH, PF, Hz
 - 2) W, VAR, A, VA Demand
 - 3) A, V Unbalance
5. Power Analysis Functions.
 - a. Total Harmonic Distortion
 - b. Individual harmonics
 - c. Waveform capture
 - d. Historical data
 - e. Minimum and maximum metered values complete with time and date
 - f. Record of last 40 events
 - g. Two independent data logs
6. User Interface and Programming
 - a. Integrated keypad to access actual values and setpoints.
 - 1) 2 - line, 40 character illuminated display for use with keypad.
The display shall have:
 - Variable scrolling rates.
 - Front mounted LEDs to display alarms, communication status, relay status, simulation mode, self test failure, and setpoint access status.
 - Relay reset button to clear alarm and auxiliary conditions.
 - b. The meter shall have one alarm output relay with Form C contacts.

- c. Relay output shall be through alarm, auxiliary and pulse output functions.
 - d. The meter shall provide a user configurable pulse output based on KWH, KVARH or KVAH.
 - e. The meter shall provide a pulse input for demand synchronization.
 - f. The meter shall include a simulation mode capability for testing the functionality and meter response to programmed conditions without the need for external inputs.
 - g. The relay shall include a power systems option consisting of harmonic analysis, triggered trace memory waveform capture, event record and data logger functions.
7. Control Power:
- a. Range of available control power: DC: 88-300 VDC; AC: 70-265 VAC, 48 to 62 Hz.
 - b. LO Range: DC: 20-60 VDC; AC: 20-48 VAC, 48 to 62 Hz.
8. Communication
- a. For remote monitoring, the following communication ports shall be provided:
 - 1) One (1) Industry Standard port for meter and relay programming using a laptop computer.
 - 2) One (1) RS-485 port.
 - 3) One (1) integral 10/100BaseT Ethernet port. The connection shall support Modbus TCP, Ethernet IP and SNMP. Where an integral port is not available, provide a media protocol converter as specified herein.
 - b. The protocol interface shall implement the following:
 - 1) All data shall be available and/or mirrored within the Modbus 4x or "Holding Register" memory area.
 - 2) Register 4x00001 shall exist and be readable to allow simple, predictable "comm tests".
 - c. The media protocol converter shall meet the following criteria:
 - 1) The converter shall support 10/100Base-T Ethernet. The serial port speed (baud rate) shall support 230kbps. The protocol shall support Modbus TCP, Ethernet IP, DF1, and Modbus RTU/ASCII. Protocol shall be Web Browser configurable.
 - 2) Operating limits shall be 0-60 degrees C, with humidity range minimum of 5-90 percent. Shock capability on the serial port shall be ESD +15 kV air GAP meeting IEC 1000-4-2. Power requirements shall be 9-30VDC at 0.5A minimum.
 - 3) The converter shall have LED status for serial, signals, power, and Ethernet.

- 4) The converter housing shall be UL 1604, Class 1 Div 2, DIN Rail mountable. The converter shall have DB-9M port connection, with screw terminals, to the input.
- 5) Converter shall be Digi One IAP, or approved equal.

2.6 NETWORK AND COMMUNICATION EQUIPMENT

A Ethernet Network Switch – Industrial Ethernet Layer 3 Modular

1. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - a. Cisco IE3000 Series
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
3. Environmental
 - a. Operating temperature: -40° F to 167° F
 - b. Operating humidity: 10 – 95% non-condensing
 - c. Storage Temperature: -13° F to 185° F
 - d. Electrical certification: UL 508, UL 60950-1
4. Physical
 - a. Enclosure: General purpose, DIN-rail, surface or 19” rack mountable
 - b. Power Supply: 120 VAC from UPS source
 - c. Microprocessor based managed type.
 - d. Modular, feature-based construction
5. Functional Performance
 - a. Per Port status LED indication
 - b. Port based Ethernet MAC security individually port configurable.
 - c. Wire Speed switching, 16 Gigabit Switching Fabric
 - d. HSRP Protocol Support
 - e. Cisco Express Forwarding Hardware Routing Architecture
 - f. SNMPv1, SNMPv2c, and SNMPv3 Support
 - g. 802.1d Spanning Tree Protocol Support
 - h. HTTPS accessible
 - i. Cisco Smartport templates for Ethernet/IP
 - j. PROFINET v2 certification

- k. Alarm Contacts for external fault notification.
 - l. 10/100BaseT ports with RJ-45 connectors for Category 6 cabling
 - m. Switch configuration stored on swappable Flash memory module
 - n. LC type Fiber Optic Connectors for 100BaseFX, 1000BaseSX for Multimode Fiber and 1000BaseLX for Single-mode Fiber as shown on the drawings
 - o. Fully managed switch capability.
6. Options and Accessories Required:
- a. Provide maximum installation space for additional future modules for each switch location.
 - b. Provide manufacturer's AC power module(s) to provide sufficient power for fully configured switch.
 - c. Provide two (2) spare ports for each port type.
- B. Industrial Ethernet Media Converter
- 1. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - a. B & B Electronics
 - 2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
 - 3. Environmental
 - a. Operating temperature: 32° F to 104° F
 - b. Operating humidity: 20 – 95% Non-condensing
 - c. Storage Temperature: -40° F to 158° F
 - 4. Physical
 - a. Power Supply: 24 VDC
 - b. Microprocessor based managed type.
 - c. DIN Rail mountable.
 - 5. Functional Performance
 - a. Per Port status LED indication
 - b. Wire Speed switching.
 - 1) 10/100BaseT ports with RJ-45 connectors for Category 6 cabling; provide with PoE as shown on the drawings.
 - 2) ST or SC type Fiber Optic Connectors for 100BaseFX, 1000BaseSX for Multimode Fiber and 1000BaseLX for Single Mode fiber as shown on the drawings.

6. Options and Accessories Required:
 - a. Provide minimum 3-year warranty.
- C. Industrial Serial to Fiber Media Gateway
1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - a. Moxa Mgate Series
 - b. B&B Electronics MESR900 Series
 - c. Approved Equal
 2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
 3. Environmental
 - a. Operating temperature: - 32 Degrees F to 140 Degrees F Minimum
 - b. Operating humidity: 20 – 95% Non-condensing
 - c. Storage Temperature: -40 to 158 Degrees F
 4. Physical
 - a. Power Supply: 12 VDC to 48 VDC Range
 - b. Microprocessor based managed type.
 - c. DIN Rail mountable.
 - d. Class 1 Division 2 rated
 - e. UL Listed
 5. Functional Performance
 - a. Configurable from supplied utility or via Web Interface.
 - b. Media and protocol conversion as further defined elsewhere in the contract documents.
 - c. Fiber Optic Connectors for Multimode or Single Mode Fiber as shown on the drawings.
 - d. RS-485 Ports with terminals. Selectable link termination (100 ~120 Ohms)
 - e. Low Latency, High Throughput.
 - f. Pass-through Ethernet Port
 6. Protocol requirements
 - a. The System shall communicate utilizing the Native Protocol of the Master device as required. Ethernet/IP as defined by ODVA.
 - b. Ethernet/IP Protocol with the following as minimum capabilities:

- 1) Transfer of basic I/O data via User Datagram Protocol (UDP)-based implicit messaging
 - 2) Uploading and downloading of parameters, set points, programs and recipes via TCP (i.e., explicit messaging.)
 - 3) Polled, cyclic and change-of-state monitoring via UDP, such as RPI and COS in Allen Bradley's ControlLogix control systems.
 - 4) One-to-one (unicast), one-to-many (multicast), and one-to-all (broadcast) communication via TCP
 - 5) Use of well-known TCP port number 44818 for explicit messaging and UDP port number 2222 for implicit messaging.
7. Options and Accessories Required:
- a. Provide minimum 5-year warranty.
 - b. The System shall communicate utilizing the Native Protocol of the Master device as required. Ethernet/IP as defined by ODVA and / or Modbus TCP Protocol as defined the Modbus Organization.

D. Communication Cables

1. Cables for Ethernet and serial communications shall be rated and shall be:
 - a. Category 5e above Grade Shielded Cable Conductors: 4 bonded pair
24AWG Bare Copper Insulation: Polyolefin
Shield: 100 percent aluminum foil polyester tape with drain wire
Jacket: PVC with 600 volts rated and manufacturer's identification
Misc.: UL21047 and UL1666 listed for indoor and dry locations use
Manufacturers: Belden 7957A or approved equal
 - b. Category 5e above Grade un-shielded Cable Conductors: 4 bonded pair
24AWG Bare Copper Insulation: Polyolefin
Jacket: PVC with 300 volts rated and manufacturer's identification NEC
CMR
Misc.: UL1666 listed for indoor and dry locations use
Manufacturers: Belden 7923A or approved equal
 - c. Category 6 above Grade Shielded Cable Conductors: 4 bonded pair 23
AWG Bare Copper Insulation: Polypropylene
Shield: 100 percent aluminum foil polyester tape with drain wire Jacket:
PVC with 600 volts rated and manufacturer's identification
Transmission Standards: Category 6 - TIA 568.C.2 NEC CMR Flame
Test Method: UL1666 Vertical Riser listed for indoor and dry locations
use
Manufacturers: Belden 7953A or approved equal
 - d. Category 6 above Grade un-shielded Cable Conductors: 4 bonded pair
23 AWG Bare Copper Insulation: Polyolefin
Jacket: PVC with 300 volts rated and manufacturer's identification
Transmission Standards: Category 6 - TIA 568.C.2
Nominal Velocity of Propagation: 72 %
Flame Test Method: UL1666 Vertical Riser listed for indoor and dry

locations use
Manufacturers: Belden 7940A or approved equal

- e. 485 Communications Cable
Conductors: 1 pair 24AWG Tinned Copper Insulation: Polyethylene
Shield: 100 percent aluminum foil polyester tape with tinned copper
drain wire Jacket: PVC with 300 volts rated and manufacturer's
identification
Misc.: UL2919 listed for indoor and dry locations use
Manufacturers: Belden 9841 or approved equal

2. Color code for Ethernet communications cables shall be as follows.

- a. Green – Phone
- b. Red – FIRE / Security
- c. Blue – Administrative Network
- d. Yellow – SCADA

E. Ethernet Surge Protectors

- 1. Subject to compliance with the contract documents, the following manufacturers are acceptable:
 - a. Transtector
 - b. PolyPhaser
 - c. Phoenix Contact
 - d. Cooper Bussman
- 2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
- 3. Environmental
 - a. Operating temperature: -40° F to 176° F
 - b. Operating humidity: 95% non-condensing for indoor applications
 - c. Storage Temperature: -40 to 176° F
- 4. Physical
 - a. DIN rail mountable indoors
 - b. I/O connectors: RJ-45
 - c. Power over Ethernet POE+ to IEEE802.3 at up to 57 VDC
- 5. Functional Performance
 - a. Protection: handles 100 or more lightning strikes at surge levels of 8/20uSec at 6kV/3kA
- 6. Standard: Compliant to IEC61000-4-5.

2.7 SURGE PROTECTIVE DEVICES (SPD UL 1449 TYPE 3)

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable (Type 3):
1. EDCO SLAC Series
 2. Phoenix Contact
 3. Brick Wall Model PWOM20
 4. Approved Equal
- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
- C. Construction of Type 3.SPD
1. Fully Integrated Component Design: All of the SPDs components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality will not be accepted.
 2. Maintenance Free Design: The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries are not acceptable. SPDs requiring any maintenance of any sort such as periodic tightening of connections are not acceptable.
 3. Electrical Noise Filter: Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method.
 4. Internal Connections: No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
 5. Power and ground connections shall be prewired within the protected equipment.
 6. Local Monitoring: Visible indication of proper SPD connection and operation shall be provided. The indicator light shall indicate that the module is fully operable. The status of each SPD module shall be monitored on the front cover of the module.
 7. SPD shall be listed in accordance with UL 1449 Third Edition and UL 1283, Electromagnetic Interference Filters.
 8. SPD shall be tested with the ANSI/IEEE Category C High exposure waveform (20 kV-1.2/50 μ s, 10 kA-8/20 μ s).
- D. Related Equipment Protection (Type 3) Installation
1. Locate the SPD on the load side of the ground and neutral connections.

2. The SPD shall be connected through a disconnect circuit breaker or fuse as shown on the drawings. The disconnection means shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.
3. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.8 ACCESSORIES:

- A. Provide the following accessories:
1. 1 – Breaker lifting truck.
 2. 1 – Breaker test equipment.
 3. 1 – Test cabinet
 4. 1 – Test jumper cables
 5. 1 – Manual ground and test device
 6. 1 – Motorized remote-control racking device
 7. 1 – Manual control racking device
 8. 1 – Manufacturer shall furnish and install a non-conducting switchgear floor mat, minimum 3/8-inch-thick by 3 feet wide, meeting ANSI/ASTM D-178-01 Type 2 Class 3, Wearwell 702 or equal, and extending the full length of the equipment lineup.

2.9 SPARE PARTS:

- A. Provide the following spare parts:
1. 1 – Complete breaker assembly for each type and size of breaker.
 2. 3 – Control fuses of each type used
 3. 1 - dozen each of cover bolts, spring nuts and door fasteners.
 4. 1 – box of each color LED light
 5. 1 - quart of touch-up paint.
- B. Spare parts shall be boxed or packaged for long term storage and clearly identified on the exterior of package. Identify each item with manufacturers name, description and part number

2.10 FACTORY TESTING – SWITCHGEAR:

- A. The following standard factory tests shall be performed on the circuit breaker element provided under this Section. All tests shall be in accordance with the latest version of ANSI standards.
1. Alignment test with master cell to verify all interfaces and interchangeability
 2. Circuit breakers operated over the range of minimum to maximum control voltage

3. Factory setting of contact gap
 4. One-minute dielectric test per ANSI standards
 5. Final inspections and quality checks
- B. The following production test shall be performed on each breaker housing:
1. Alignment test with master breaker to verify interfaces
 2. One-minute dielectric test per ANSI standards on primary and secondary circuits
 3. Operation of wiring, relays and other devices verified by an operational sequence test
 4. Final inspection and quality check.
- C. The manufacturer shall provide three (3) certified copies of factory test reports.

2.11 FACTORY TEST REPORTS:

- A. Following completion of factory tests, the Manufacturer shall furnish to the Owner/Engineer, for review and approval, four (4) certified copies of all test data required by the Specifications. The Owner/Engineer will promptly review test data and, upon determining that the equipment meets contract requirements, authorization will be given for jobsite delivery. Incomplete equipment or equipment failing factory tests will not be accepted at the jobsite. Delivery shall not be made, without written approval of test data by the Owner/Engineer, except at the risk of the Manufacturer.

PART 3 EXECUTION

3.1 MANUFACTURER'S REPRESENTATIVE:

- A. Provide the services of a qualified factory-trained manufacturer's field engineer to assist the Contractor in installation and start-up of the equipment specified under this Section for a period of not less than 10 working days. The manufacturer's representative shall provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.
- B. The Contractor shall provide three (3) copies of the manufacturer's field start-up report.

3.2 MANUFACTURER'S CERTIFICATION:

- A. A qualified factory-trained manufacturer's representative shall personally inspect the equipment at the jobsite and shall certify in writing that the equipment has been installed, adjusted, and tested, in accordance with the manufacturer's recommendations, including all settings designated in the Power System Study.
- B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification.

3.3 FIELD ADJUSTING:

- A. Adjust all circuit breakers, switches, access doors, operating handles for free mechanical and electrical operation as described in Manufacturer's instructions.

- B. The Power Monitoring and Protective Relays shall be set in the field by a qualified representative of the Manufacturer, in accordance with settings designated in a coordinated study of the system as required in Section 16105 Power System Study. All such settings, including the application of arc flash labels, shall have been made and Approved by the Owner/Engineer, prior to energizing of the equipment.
- C. Return Extra Kirk keys to the Owner after final acceptance.

3.4 FIELD TESTING – SWITCHGEAR:

- A. Megger and record phase to phase and phase to ground insulation resistance of each bus section. Megger for 1 minute for each measurement at minimum voltage of 5000 VDC. Measured Insulation resistance shall be at least 1000 megohms.
- B. Test each key interlock system for proper functioning.

3.5 TRAINING:

- A. Provide manufacturer's services for training of plant personnel in operation and maintenance of the equipment furnished under this Section.
- B. The training shall be for a period of not less than one (1) eight-hour day.
- C. The cost of training program to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.
- D. Provide detailed O&M manuals to supplement the training course. The manuals shall include specific details of equipment supplied and operations specific to the project.
- E. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, circuit breaker, protective devices, metering, and other major components.
- F. The Owner shall have the right to record a videotape of the training for the Owner's use.

END OF SECTION

SECTION 16482
MEDIUM VOLTAGE MOTOR CONTROL CENTERS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This specification describes a complete assembly to be furnished by a single Medium Voltage Motor Control Center Manufacturer (Manufacturer) for installation by Others (Contractor).
- B. The Manufacturer shall furnish and install assemblies of Class E2 medium voltage motor control centers (MVMCCs), together with appurtenances, complete and operable, as specified herein and as shown on the Contract Drawings.
- C. Medium voltage motor control centers shall be sized to include all equipment, spares and spaces shown on the Drawings.

1.02 RELATED WORK (NOT USED)

1.03 SUBMITTALS

- A. Pre-Purchase Contract Schedule: It is anticipated that this pre-purchase contract will follow the approximate schedule below:
 - 1. Submittals-Preliminary: (with the bid)
 - 2. Submittals: September 14, 2018
- B. The Manufacturer shall provide the following with the bid:
 - 1. Equipment outline drawings showing elevation and plan views, dimensions, weight, shipping splits and metering layouts. Indicate all options, special features, ratings and deviations from the Specifications.
 - 2. Bus arrangement drawings.
- C. The Manufacturer shall provide the following with Submittals (September 14, 2018)
 - 1. Equipment outline drawings showing elevation and plan views, dimensions, weight, shipping splits and metering layouts. Indicate all options, special features, ratings and deviations from the Specifications.
 - 2. Conduit entrance drawings, including floor penetrations.
 - 3. Bus arrangement drawings.
 - 4. Unit summary tables showing detailed equipment description and nameplate data for each compartment.
 - 5. Product data sheets and catalog numbers for overcurrent protective devices, motor starters, control relays, control stations, meters, pilot lights, etc. List all options, trip adjustments and accessories furnished specifically for this project. Clearly mark each sheet to indicate which items apply and/or those items that do not apply.

6. Provide control systems engineering to produce custom unit elementary drawings showing interwiring and interlocking between units and to remotely mounted devices. Show wire and terminal numbers. Indicate special identifications for electrical devices per the Drawings.
 7. Master drawing index
 8. Front view elevation
 9. Floor plan
 10. Top view
 11. Single line
 12. Schematic diagram, including manufacturer's selections of component ratings, and CT and PT ratios.
 13. Nameplate schedule
 14. UL Listing of the completed assembly.
 15. Component list with detailed component information, including original manufacturer's part number.
 16. Conduit entry/exit locations
 17. Assembly ratings including:
 - a. Short-circuit rating
 - b. Voltage
 - c. Continuous current
 - d. Basic impulse level
 18. Major component ratings including:
 - a. Voltage
 - b. Continuous current
 - c. Interrupting ratings
 19. Power factor correction capacitor size (kVAR)
 20. Descriptive bulletins
 21. Product data sheets.
 22. Number and size of cables per phase, neutral if present, ground and all cable terminal sizes.
 23. Instruction and renewal parts books.
 24. Itemized list of spare parts furnished specifically for this project, including quantities, description and part numbers.
- D. The Manufacturer shall submit the following under the Contractor's scope of supply and not with the Pre-Purchased Contract:

1. Operations and Maintenance Manual as specified in Section 01730 and herein.
 2. Protective Relay Settings.
 3. Delivery, storage, and handling instructions.
 4. Factory Tests. Submittals shall be made for factory tests specified herein.
 5. Field Test Reports. Submittals shall be made for field tests specified herein.
- E. Submittals shall be made in accordance with the requirements of Section 01300 and as specified herein.
- F. Provide systems engineering to produce power factor correction capacitor study. The study shall include the appropriate sizing of the power factor correction capacitors for new motors, as well as all new reactive loads. The Manufacturer shall obtain all pertinent data from the new motor name plates and their respective manufacturer to size the capacitors to deliver a power factor of 95 percent or as close to 95 percent as possible without over-excitation of the motor. The Manufacturer shall obtain the maximum capacitor size from the new motor manufacturer, and present the data in the study.
- G. The Manufacturer shall create all MVMCC shop drawings, including all wiring diagrams, in the Manufacturer's engineering department. All MVMCC shop drawings shall bear the Manufacturer's MVMCC logo, drawing file numbers, and shall be maintained on file in the Manufacturer's MVMCC archive file system. Photocopies of the Engineer's ladder schematics are unacceptable as shop drawings.
- H. Operation and maintenance manuals shall include the following information:
1. Manufacturer's contact address and telephone number for parts and service.
 2. Warranty Certificate complete with relevant contact information.
 3. Instruction books and/or leaflets.
 4. Recommended renewal parts list.
 5. Record drawings of equipment supplied.
 6. Certified copies factory test reports.

1.04 REFERENCE CODES AND STANDARDS

- A. The medium voltage motor control centers and all components in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
1. ANSI/IEEE C57.13, Standard Requirements for Instrument Transformers.
 2. IEEE C37.90, Standard for Relays and Relay Systems Associated with Electric Power Apparatus
 3. NEMA SG 2, High Voltage Fuses
 4. ANSI/NEMA ICS 6 – Enclosures for Industrial Controls and Systems
 5. NEMA ICS 1 – General Standard for Industrial Control Systems
 6. NEMA ICS 3, Part 2

7. UL 347 – High Voltage Industrial Control Equipment
 8. NFPA 70 – National Electrical Code (NEC)
 9. NFPA 70E – Standard for Electrical Safety in the Workplace
- B. All equipment components and completed assemblies specified in this Section of the Specifications shall bear the appropriate label of Underwriters Laboratories.

1.05 QUALITY ASSURANCE

- A. The manufacturer of this equipment shall have produced similar equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- B. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly. All assemblies shall be of the same manufacturer. Equipment that is manufactured by a third party and “brand labeled” shall not be acceptable.
- C. All components and material shall be new and of the latest field proven design and in current production. Obsolete components or components scheduled for immediate discontinuation shall not be used.
- D. Equipment submitted shall fit within the space shown on the Drawings. Equipment which does not fit within the space is not acceptable.
- E. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.06 DELIVERY, STORAGE AND HANDLING

- A. The Manufacturer shall provide unloading, storage, and handling instructions prior to shipment.
- B. All equipment shall be delivered in good, sound condition, and free from damage. Equipment which has been damaged will be rejected.
- C. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Breakers and accessories shall be packaged and shipped separately.
- D. Equipment shall be equipped to be handled by crane. Where cranes are not available, equipment shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.
- E. The Contractor shall be responsible for proper unloading, handling, and storage of equipment in accordance with the Manufacturer’s instructions.

1.07 WARRANTY

- A. The Manufacturer’s warranty period shall be concurrent with Contractor’s for two (2) years, commencing at the time of final acceptance by the Owner which shall begin no later than April 15, 2020. Guarantee shall cover all necessary labor, equipment, materials and replacement parts resulting from faulty or inadequate equipment design, improper assembly, defective workmanship and materials, breakage or other failure of all equipment and components furnished by the Manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - 1. Eaton Cutler Hammer
 - 2. Siemens
 - 3. General Electric
 - 4. Schneider Electric Square D
- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.02 RATINGS

- A. The voltage, current and short circuit current ratings of the motor control centers shall be as shown on the Drawings.
- B. Motor controller ratings, NEMA 1A, with current limiting fuses shall be as follows:

4 kV
320A
450 Hp
350 MVA

- C. The vacuum contactor (NEMA 1A) shall be as follows:

<u>7200V Max.</u>	<u>400 Amperes</u>	<u>800 Amperes</u>
Maximum Interrupting Current (3 Ops)	6000 Amps	9,000 Amps
Rated Current – Enclosed	320 Amps	640 Amps
Rated Current – Open	400 Amps	800 Amps
Short Time Current		
30 Seconds	2400 A	4800 A
1 Second	6000 A	12,000 A
Impulse Withstand	60kV	60kV

D. Feeder and Main load break switch NEMA 1A ratings shall be as follows:

Maximum Voltage (Kv)	BIL Rating (Kv)	Continuous Current (Amperes)	Interrupting Capacity (Amperes)		Momentary Current		Fault Closing Current Asym. Amps.
			At 0.8 PF	At 1.0 PF	10 Cycles Asym.	4 Seconds Sym.	
5.5	60	540	600	600	61,000	25,000	61,000
5.5	60	1020	1200	1200	61,000	38,000	61,000

E. Motor control centers, including devices, shall be designed for continuous operation at rated current in 40-degree C ambient temperature.

F. For additional ratings and construction notes, refer to the Drawings.

2.03 CONSTRUCTION

A. General

1. Refer to Drawings for: actual layout and location of equipment and components; current ratings of devices, bus bars, components; protective relays, voltage ratings of devices, components and assemblies; and other required details.
2. Units shall be arranged as shown on the Drawings.
3. Where the equipment contains an uninterruptible power supply (UPS), the equipment manufacturer shall furnish factory installed, a dedicated Point of Utilization Device (SPD), as specified herein
4. Nameplates
 - a. External
 - 1) Furnish nameplates for each device as specified herein and as indicated on the Drawings. All nameplates shall be laminated plastic, black lettering on a white background, attached with stainless steel screws. There shall be a master nameplate that indicates equipment ratings, manufacturer's name, shop order number and general information. Cubicle nameplates shall be mounted on the front face, on the rear panel and inside the assembly, visible when the rear panel is removed.
 - b. Internal
 - 1) 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.

- 2) The manufacturer shall not remove, reuse, alter, or replace original equipment nameplates or equipment tags associated with equipment or components supplied by the manufacturer's suppliers and sub-suppliers.

c. Special

- 1) Identification nameplates shall be white with black letters, caution nameplates shall be yellow with black letters, and warning nameplates shall be red with white letters.

5. Control Devices and Indicators

- a. All operating control devices, indicators, and instruments shall be securely mounted on the panel door. All controls and indicators shall be 30mm, corrosion resistant, NEMA 4X/13, anodized aluminum or reinforced plastic. Booted control devices are not acceptable. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical and electrical equipment requirements.
- b. Indicator lamps shall be LED type. For all control applications, indicator lamps shall incorporate a push-to-test feature. Lens colors shall be as follows:
 - 1) Red for ON, Valve OPEN, and Breaker CLOSED.
 - 2) Green for OFF, Valve CLOSED and Breaker OPEN.
 - 3) Amber for FAIL.
 - 4) Blue for READY
 - 5) White for POWER ON.
- c. Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, etc) shall be as shown on the Drawings. Units shall have the number of positions and contact arrangements, as required. Each switch shall have an extra dry contact for remote monitoring.
- d. Pushbuttons, shall be as follows:
 - 1) Red for STOP, Valve OPEN, Breaker OPEN and mushroom Red for EMERGENCY STOP.
 - 2) Green for START, Valve CLOSE and Breaker CLOSE.
 - 3) Black for RESET.

- e. Furnish nameplates for each device. All nameplates shall be laminated plastic, black lettering on a white background, attached with stainless steel screws. Device mounted nameplates are not acceptable.
6. Control and Instrument Power Transformers
- a. Control power transformers shall be provided where shown on the Drawings. Transformer shall be sized for the entire load, including space heaters, plus 25% spare capacity, and shall be not less than 1000VA.
 - b. Control power transformers shall be 120 volt grounded secondary. Primary side of the transformer shall be fused in both legs. One leg of the transformer secondary shall be solidly grounded and the other leg shall be fused.
- B. Enclosures
- 1. Enclosures shall be NEMA 12, unless otherwise shown on the Drawings or specified elsewhere.
 - 2. Enclosures shall be 90 inches high, 22 to 48 inches wide and 30 inches deep, completely front connected.
 - 3. Controllers shall be mounted not more than one per vertical cubicle.
 - 4. The MVMCC shall be supported on a heavy gauge, welded steel channel base extending around all four sides, constructed to exclude rodents, vermin, and dust.
 - 5. Interlocks shall be furnished to prevent operation of the isolating mechanism under load, operating of the high voltage compartment before the controller is isolated, and closing of the line contactors while the door is opened.
 - 6. All non-current carrying metal parts of the control center assembly shall be cleaned of all weld spatter and other foreign material and given a heat cured, phosphatized chemical pre-treatment to inhibit rust.
 - 7. Indoor equipment shall be finish painted with one coat of the Manufacturer's standard electrocoated heat cured enamel.
 - 8. Each starter shall have a print pocket containing a laminated copy of all schematics related to the starter.
 - 9. All cables shall enter and exit underground from the bottom of the cubicle, unless otherwise shown on the Drawings.
 - 10. Each vertical section shall be provided with a heavy duty, 240VAC space heater, thermostat controlled, of sufficient capacity to prevent condensation with the equipment de-energized. Heaters shall operate at half voltage for extended life. Power for space heaters shall be furnished from a control transformer mounted in the MVMCC.

C. Construction

1. Isolating switch and contactor assemblies, including current limiting fuses, shall be of the component-to-component design with a minimum amount of interconnecting cables. Line and load cable terminations shall be completely accessible from the front.
2. The isolating switch shall be an externally operated manual three-pole, such that in the open position it isolates the starter from the line connectors. Integral mechanical interlocks shall prevent entry into the high-voltage areas while the starter is energized and shall block accidental opening or closing of the isolating switch when the door is open or the contactor is closed. The isolating switch handle shall have provisions for padlocking in the open position. The isolating switch shall have a mechanical blown fuse indicating device.
3. Current limiting power fuses shall be provided with special fatigue proof elements that allow the elements to absorb the expansions and contractions created by the heating and cooling associated with severe cycling as is typical with motor starting. The fuses shall include visible fuse condition indicators. The fuses shall incorporate special time/current characteristics for motor service allowing proper coordination with the contactor and overload relay for maximum motor protection. This coordination shall be such that under a low-fault condition the interrupting rating and dropout time of the contactor shall be properly coordinated with all possible fuse sizes to eliminate contactor racing. The power fuses shall be mounted to permit easy inspection and replacement without starter disassembly.
4. The vacuum contactors shall be of the draw-out, magnetically-held, and/ or latched design, rated for the load it serves. Contactor shall have single-break high-pressure type main contacts with weld-resistant alloy contact faces. The vacuum contactor contact wear shall be such that the gap can be checked with the use of a “go/no-go” feeler gauge.
5. A built-in test circuit shall be included to permit checking of the starter control and pilot circuit, with the high voltage de-energized and isolated, and the contactor in its normal position or in the drawout position. The control circuit shall be capable of being energized through a polarized plug connector from an external 115-volt supply while in the test mode.
6. The low voltage control compartment shall be isolated and barriered from the high voltage area and mounted on a panel with a separate low voltage access door. The low voltage control components shall be accessible by the use of a low voltage control compartment.
7. Each starter cell shall contain a vertical and horizontal low voltage wireway.

D. Busses

1. When starters are grouped together in a lineup, the horizontal main bus shall be located in its own separate, enclosure and isolated from the starters. Each phase

shall be insulated. To allow for ease of maintenance or extension of lineups without disassembling starters, the main bus shall be front, and side accessible.

2. Starters shall be connected by an insulated vertical bus.
3. All bus bars shall be tin-plated copper, rated as shown on the Drawings
4. Provide a 1/4 x 2-inch ground bus throughout the entire lineup. Ground bus shall also be supplied in upper compartments of 2-high starters and be bus connected to the ground bus supplied in the lower compartments.

E. Wiring

1. All control wire shall be UL/CSA approved.
2. Standard control wire shall be 14GA, stranded, tin-plated, red, dual-rated type XLPE (3173) 125 degrees C, SIS 90 degrees C.
3. Current transformer circuits shall utilize #12 wire with the same characteristics as above. Provide shorting blocks for all current transformers.
4. Provide “plug-in” terminal blocks, rated 600 V, 50 A with “clamping collar.”
5. Wire markers shall be a molded plastic “clip-sleeve” type.
6. “Clamping-collar” type terminals shall be used to terminate control wiring. Current transformer circuits shall be provided with ring-type terminals where applicable.
7. All field wiring shall be tagged and coded with an identification number as shown on the Drawings. Coding shall be typed on a heat shrinkable tube applied to each end showing origination and destination of each wire. The marking shall be permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE, or equal.
8. Terminations shall be completely accessible from the front.

2.04 MAIN SECTION

A. General

1. The MVMCC main sections shall consist of main switches, power fuses and power feeder entrance to the MVMCC. Where a power feeder entrance is shown on the Drawings, the power feeder entrance section shall be provided. Provide bus extensions and compression lugs for number and size of incoming cables as shown on the Drawings.

B. Feeder Switches

1. Furnish, where shown on the contract drawings, three-pole manually operated quick-make, quick-break load break switches or integrated metal enclosed breakers.

2. The fixed-mounted switches shall fit in a standard 90-inch high, 36-inch wide vertical structure, and shall be fused. Provide mechanical interlocks such that the switch door cannot be opened when the switch is on, and when the door is open the switch cannot be closed. A safety screen shall be provided behind the switch door.
- C. Lightning Arresters and Surge Capacitors
1. Provide three (3) intermediate type lightning arresters rated 3kV and surge capacitors on each incoming line where shown on the Drawings. Arresters and capacitors shall be factory installed.
- D. Furnish lugs for incoming line feeders, sizes as specified. Allow adequate clearance for bending and terminating of cable size and type specified.

2.05 MOTOR CONTROLLERS

- A. General
1. The starters shall be designed to accommodate motors of the size and type as shown on the Drawings.
 2. The starters shall accommodate the following motor types:
 - a. Induction Motor Full-Voltage Start
 - b. All induction motor controllers shall have integral three-phase power factor correction capacitors with inductors connected on the load side of the run contactor.
- B. Assemblies
1. The following equipment shall be provided for the starter types shown on the Drawings.

Each induction motor full voltage starter shall include:

 - 1) Medium Voltage Section
 - a) One – Fixed portion isolating switch
 - b) One – Removable portion isolating switch with blown fuse indication
 - c) Three – Clip-in Current-limiting power fuses
 - d) One – Stab-in three-pole main vacuum contactor assembly
 - e) One – Control circuit transformer
 - f) Two – Control circuit primary current limiting fuses
 - g) One – Control circuit secondary fuse
 - h) One – Run-test circuit

- i) Four – Electrical interlocks
 - j) Two – Potential Transformers
 - k) Three – Current transformers
 - l) One – Zero sequence ground fault current transformer
 - m) One – Integral three-phase power factor correction capacitor (PFCC) with inrush reactor
 - n) IR Ports
- 2) Low Voltage Compartment and Door
- a) One – Motor Protection Relay (as specified in 2.07)
 - b) One – Lockout Relay (as specified in 2.07)
 - c) One – Control Switch
 - d) One – Ammeter Phase Selector Switch
 - e) One – Ammeter
 - f) One – Interposing control relay
 - g) One – Set of control circuit terminal blocks
 - h) Isolation switch viewing window to verify switch position
 - i) One – CT shorting terminal block

2.06 MECHANICALLY-LATCHED CONTACTOR

- A. Mechanically-latched contactor, where shown on the drawings, shall be provided. The contactor shall remain closed, if there is a loss of voltage or a reduced-voltage condition.
- B. Mechanically-latched contactor shall be closed electrically from a local or remote CLOSE pushbutton, and tripped by a mechanical linkage to an externally operated manual trip device.
- C. An electrically-operated solenoid shall be supplied to trip the contactor as indicated on the Drawings.

2.07 METERING AND PROTECTIVE RELAYS

- A. Motor Protection System (MP4)
 - 1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - a. GE Multilin 869
 - b. Approved Equal

2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
3. Minimum ANSI Functions
 - a. 14 Speed Switch
 - b. 19 Reduced Voltage Start
 - c. 27 Undervoltage
 - d. 32 Jam/Acceleration
 - e. 37 Undercurrent/Undervoltage
 - f. 38 Bearing Temperature
 - g. 46 Current Unbalance
 - h. 47 Voltage Unbalance
 - i. 49 Stator Temperature
 - j. 50 Instantaneous Current
 - k. 50g Instantaneous Ground Current
 - l. 51 Overcurrent
 - m. 51g Ground Overcurrent
 - n. 55 Power Factor
 - o. 59 Overvoltage
 - p. 66 Starts per Hour
 - q. 86 Overcurrent Lockout
 - r. 87 Differential Protection
4. General
 - a. All circuit boards shall have a harsh environment conformal coating to resist H₂S gas and other corrosive agents, including humidity.
5. Protection and Control
 - a. Thermal model biased with RTD and negative sequence current feedback
 - b. Start supervision and inhibit
 - c. Locked rotor / mechanical jam
 - 1) The relay shall protect the rotor during stall and acceleration. The stall/acceleration curve shall be voltage compensated and a speed switch input shall be available. The stator protective thermal model shall combine inputs from positive and negative sequence

currents and RTD winding feedback. The model shall be dynamic in nature in order to follow the loading and temperature of the motor.

- d. Voltage compensated acceleration
- e. Undervoltage, overvoltage
- f. Underfrequency
- g. Stator differential protection
 - 1) Differential protection using CT inputs (6) from both sides of the machine winding Voltage transformer inputs shall be used to provide overvoltage, undervoltage, voltage phase reversal, overfrequency and underfrequency functions.
- h. Thermal overload
- i. Overtemperature 12 RTD's
- j. Phase and ground overcurrent
- k. Current unbalance
- l. Power Elements
 - 1) Power factor
 - 2) Reactive power
 - 3) Underpower
 - 4) Reverse active power
 - 5) Overtorque
- m. Torque protection
- n. Reduced voltage starting control
- 6. Monitoring and Metering
 - a. Metering Functions
 - 1) A, V, W, Var, VA, PF, Hz, Wh,varh, demand
 - b. The system shall include complete power metering. An event record shall store the last 40 events. Sixteen cycles of waveform data shall be stored each time a trip occurs. A simulation feature shall be available for testing the function.
 - c. Torque, temperature
 - d. Event recorder
 - e. Oscillography and data logger
 - f. Statistical information and learned motor data

- g. Motor starting reports
- 7. Inputs and Outputs
 - a. 12 RTD's, programmable
 - b. Five predefined and four assignable digital inputs
 - c. Six output relays
 - d. Four analog inputs
 - e. Four programmable analog outputs
- 8. Memory
 - a. Memory shall be non-volatile and programming shall remain intact upon power failure.
 - b. Interface software shall be provided in a Windows® format.
- 9. User Interface
 - a. A 40-character LCD display and associated keypad to provide access to actual values and set points.
- 10. Control Power:
 - a. Range of available control power: DC: 90-300 VDC; AC: 70-265 VAC, 48 to 62 Hz.
 - b. LO Range: DC: 20-60 VDC; AC: 20-48 VAC, 48 to 62 Hz.
- 11. Communication
 - a. For remote monitoring, the following communication ports shall be provided:
 - 1) One (1) Industry Standard port for meter and relay programming using a laptop computer.
 - 2) One (1) RS-485 port.
 - 3) One (1) integral 10/100BaseT Ethernet port. The connection shall support Ethernet IP and SNMP. Where an integral port is not available, provide a media protocol converter as specified herein.
 - b. The protocol interface shall implement the following:
 - 1) All data shall be available and/or mirrored within the "Holding Register" memory area.
 - 2) Register 4x00001 shall exist and be readable to allow simple, predictable "comm tests".
 - c. The media protocol converter shall meet the following criteria:

- 1) The converter shall support 10/100Base-T Ethernet. The serial port speed (baud rate) shall support 230kbps. The protocol shall support Modbus TCP, Ethernet IP, DF1, and Modbus RTU/ASCII. Protocol shall be Web Browser configurable.
 - 2) Operating limits shall be 0-60 degrees C, with humidity range minimum of 5-90 percent. Shock capability on the serial port shall be ESD +15 kV air GAP meeting IEC 1000-4-2. Power requirements shall be 9-30VDC at 0.5A minimum.
 - 3) The converter shall have LED status for serial, signals, power, and Ethernet.
 - 4) The converter housing shall be UL 1604, Class 1 Div 2, DIN Rail mountable. The converter shall have DB-9M port connection, with screw terminals, to the input.
 - 5) Converter shall be Digi One IAP, or approved equal.
- B. Where Type 86 relays are specified or shown on the Drawings, the relay shall be a door mounted, high speed multicontact relay for trip and/or block close breaker control and contact multiplication. Contacts shall be electrically separate. Relay shall be electrical trip and manually reset. A black target shall indicate the Reset position and an orange target the Tripped position. Where the relay is shown as an output of a Motor Protective System, the Type 86 Relay functions may be incorporated into the associated Breaker Protective System, if the Protective System can provide all of the relay functions and capabilities specified above. The relay shall be a GE type HEA or approved equal.

2.08 REMOTE MONITORING AND CONTROL INTERFACE

- A. General: All control and interconnection points from the equipment to the plant control and monitoring system shall be brought to a separate connection box. No field connections shall be made directly to the equipment control devices.
- B. Discrete control or status functions shall be form C relays with contacts rated at 120 volts AC. Analog signals shall be isolated from each other.
- C. Equipment functions to be directly interfaced to the Plant Control and Monitoring System, shall be designed for operation with an Ethernet Connection.
- D. The equipment manufacturer shall factory enter the proper IP Address for such connection. Upon request by the Contractor, the Owner/Engineer will provide the proper Internet Protocol Address (IP Address), to be configured by the equipment manufacturer.

2.09 NETWORK AND COMMUNICATION EQUIPMENT

- A. Ethernet Network Switch – Industrial Ethernet Layer 3 Modular
 1. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - a. Cisco IE3000 Series

2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
3. Environmental
 - a. Operating temperature: -40° F to 167° F
 - b. Operating humidity: 10 – 95% non-condensing
 - c. Storage Temperature: -13° F to 185° F
 - d. Electrical certification: UL 508, UL 60950-1
4. Physical
 - a. Enclosure: General purpose, DIN-rail, surface or 19” rack mountable
 - b. Power Supply: 120 VAC from UPS source
 - c. Microprocessor based managed type.
 - d. Modular, feature-based construction
5. Functional Performance
 - a. Per Port status LED indication
 - b. Port based Ethernet MAC security individually port configurable.
 - c. Wire Speed switching, 16 Gigabit Switching Fabric
 - d. HSRP Protocol Support
 - e. Cisco Express Forwarding Hardware Routing Architecture
 - f. SNMPv1, SNMPv2c, and SNMPv3 Support
 - g. 802.1d Spanning Tree Protocol Support
 - h. HTTPS accessible
 - i. Cisco Smartport templates for Ethernet/IP
 - j. PROFINET v2 certification
 - k. Alarm Contacts for external fault notification.
 - l. 10/100BaseT ports with RJ-45 connectors for Category 6 cabling
 - m. Switch configuration stored on swappable Flash memory module
 - n. LC type Fiber Optic Connectors for 100BaseFX, 1000BaseSX for Multimode Fiber and 1000BaseLX for Single-mode Fiber as shown on the drawings
 - o. Fully managed switch capability.
6. Options and Accessories Required:

- a. Provide maximum installation space for additional future modules for each switch location.
 - b. Provide manufacturer's AC power module(s) to provide sufficient power for fully configured switch.
 - c. Provide two (2) spare ports for each port type.
- B. Industrial Ethernet Media Converter
- 1. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - a. B & B Electronics
 - 2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
 - 3. Environmental
 - a. Operating temperature: 32° F to 104° F
 - b. Operating humidity: 20 – 95% Non-condensing
 - c. Storage Temperature: -40° F to 158° F
 - 4. Physical
 - a. Power Supply: 24 VDC
 - b. Microprocessor based managed type.
 - c. DIN Rail mountable.
 - 5. Functional Performance
 - a. Per Port status LED indication
 - b. Wire Speed switching.
 - c. 10/100BaseT ports with RJ-45 connectors for Category 6 cabling; provide with PoE as shown on the drawings.
 - d. ST or SC type Fiber Optic Connectors for 100BaseFX, 1000BaseSX for Multimode Fiber and 1000BaseLX for Single Mode fiber as shown on the drawings.
 - 6. Options and Accessories Required:
 - a. Provide minimum 3-year warranty.
- C. Industrial Serial to Fiber Media Gateway
- 1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - a. Moxa Mgate Series

- b. B&B Electronics MESR900 Series
 - c. Approved Equal
- 2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
- 3. Environmental
 - a. Operating temperature: - 32 Degrees F to 140 Degrees F Minimum
 - b. Operating humidity: 20 – 95% Non-condensing
 - c. Storage Temperature: -40 to 158 Degrees F
- 4. Physical
 - a. Power Supply: 12 VDC to 48 VDC Range
 - b. Microprocessor based managed type.
 - c. DIN Rail mountable.
 - d. Class 1 Division 2 rated
 - e. UL Listed
- 5. Functional Performance
 - a. Configurable from supplied utility or via Web Interface.
 - b. Media and protocol conversion as further defined elsewhere in the contract documents.
 - c. Fiber Optic Connectors for Multimode or Single Mode Fiber as shown on the drawings.
 - d. RS-485 Ports with terminals. Selectable link termination (100 ~120 Ohms)
 - e. Low Latency, High Throughput.
 - f. Pass-through Ethernet Port
- 6. Protocol requirements
 - a. The System shall communicate utilizing the Native Protocol of the Master device as required. Ethernet/IP as defined by ODVA.
 - b. Ethernet/IP Protocol with the following as minimum capabilities:
 - 1) Transfer of basic I/O data via User Datagram Protocol (UDP)-based implicit messaging
 - 2) Uploading and downloading of parameters, set points, programs and recipes via TCP (i.e., explicit messaging.)

- 3) Polled, cyclic and change-of-state monitoring via UDP, such as RPI and COS in Allen Bradley's ControlLogix control systems.
 - 4) One-to-one (unicast), one-to-many (multicast), and one-to-all (broadcast) communication via TCP
 - 5) Use of well-known TCP port number 44818 for explicit messaging and UDP port number 2222 for implicit messaging.
- c. Options and Accessories Required:
- 1) Provide minimum 5-year warranty.
 - 2) The System shall communicate utilizing the Native Protocol of the Master device as required. Ethernet/IP as defined by ODVA and / or Modbus TCP Protocol as defined the Modbus Organization.

D. Communication Cables

1. Cables for Ethernet and serial communications shall be rated and shall be:
 - a. Category 5e above Grade shielded Cable Conductors: 4 bonded pair 24AWG Bare Copper Insulation: Polyolefin
Shield: 100 percent aluminum foil polyester tape with drain wire Jacket: PVC with 600 volts rated and manufacturer's identification
Misc.: UL21047 and UL1666 listed for indoor and dry locations use
Manufacturers: Belden 7957A or approved equal
 - b. Category 5e above Grade un-shielded Cable Conductors: 4 bonded pair 24AWG Bare Copper Insulation: Polyolefin
Jacket: PVC with 300 volts rated and manufacturer's identification NEC CMR
Misc.: UL1666 listed for indoor and dry locations use
Manufacturers: Belden 7923A or approved equal
 - c. Category 6 above Grade shielded Cable Conductors: 4 bonded pair 23 AWG Bare Copper Insulation: Polypropylene
Shield: 100 percent aluminum foil polyester tape with drain wire Jacket: PVC with 600 volts rated and manufacturer's identification Transmission Standards: Category 6 - TIA 568.C.2 NEC CMR Flame Test Method: UL1666 Vertical Riser listed for indoor and dry locations use
Manufacturers: Belden 7953A or approved equal
 - d. Category 6 above Grade un-shielded Cable Conductors: 4 bonded pair 23 AWG Bare Copper Insulation: Polyolefin
Jacket: PVC with 300 volts rated and manufacturer's identification Transmission Standards: Category 6 - TIA 568.C.2
Nominal Velocity of Propagation: 72 %
Flame Test Method: UL1666 Vertical Riser listed for indoor and dry locations use

Manufacturers: Belden 7940A or approved equal

- e. 485 Communications Cable
Conductors: 1 pair 24AWG Tinned Copper Insulation: Polyethylene
Shield: 100 percent aluminum foil polyester tape with tinned copper drain
wire Jacket: PVC with 300 volts rated and manufacturer's identification
Misc.: UL2919 listed for indoor and dry locations use
Manufacturers: Belden 9841 or approved equal

2. Color code for Ethernet communications cables shall be as follows.

- a. Green – Phone
- b. Red – FIRE / Security
- c. Blue – Administrative Network
- d. Yellow – SCADA

E. Ethernet Surge Protectors

1. Subject to compliance with the contract documents, the following manufacturers are acceptable:

- a. Transtector
- b. PolyPhaser
- c. Phoenix Contact
- d. Cooper Bussman

2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

3. Environmental

- a. Operating temperature: -40° F to 176° F
- b. Operating humidity: 95% non-condensing for indoor applications
- c. Storage Temperature: -40 to 176° F

4. Physical

- a. DIN rail mountable indoors
- b. I/O connectors: RJ-45
- c. Power over Ethernet POE+ to IEEE802.3 at up to 57 VDC

5. Functional Performance

- a. Protection: handles 100 or more lightning strikes at surge levels of 8/20uSec at 6kV/3kA
- b. Standard: Compliant to IEC61000-4-5.

2.10 SURGE PROTECTIVE DEVICES (SPD UL 1449 TYPE 3)

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable (Type 3):
1. EDCO SLAC Series
 2. Phoenix Contact
 3. Brick Wall Model PWOM20
 4. Approved Equal
- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
- C. Construction of Type 3 SPD
1. Fully Integrated Component Design: All of the SPDs components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality will not be accepted.
 2. Maintenance Free Design: The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries are not acceptable. SPDs requiring any maintenance of any sort such as periodic tightening of connections are not acceptable.
 3. Electrical Noise Filter: Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method.
 4. Internal Connections: No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
 5. Power and ground connections shall be prewired within the protected equipment.
 6. Local Monitoring: Visible indication of proper SPD connection and operation shall be provided. The indicator light shall indicate that the module is fully operable. The status of each SPD module shall be monitored on the front cover of the module.
 7. SPD shall be listed in accordance with UL 1449 Third Edition and UL 1283, Electromagnetic Interference Filters.
 8. SPD shall be tested with the ANSI/IEEE Category C High exposure waveform (20 kV-1.2/50 μ s, 10 kA-8/20 μ s).
- D. Related Equipment Protection (Type 3) Installation
1. Locate the SPD on the load side of the ground and neutral connections.

2. The SPD shall be connected through a disconnect circuit breaker or fuse as shown on the drawings. The disconnection means shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.
3. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.11 SPARE PARTS

- A. Provide the following spare parts:
 1. 3 – Control fuses of type used.
 2. One dozen each of cover bolts, spring nuts and door fasteners.
 3. One quart of touch-up paint.
 4. One 400A Drawout Contactor assembly.
- B. Spare parts shall be boxed or packaged for long term storage and clearly identified on the exterior of package. Identify each item with manufacturers name, description and part number

2.12 FACTORY TESTING

- A. The MVMCC shall be completely assembled, wired and adjusted at the factory and shall be given the manufacturer's routine shop tests and any other additional operational test to ensure the workability and reliable operation of the equipment.
- B. Prior to factory testing, the Manufacturer shall check to see that all sections required by the Power System Study Engineer have been performed.
- C. Factory test equipment and test methods shall conform to the latest applicable requirements of ANSI, IEEE, UL and NEMA standards.
- D. The operational test shall include the proper connection of supply and control voltage and, as far as practical, a mockup of simulated control signals and control devices shall be fed into the boards to check for proper operation.
- E. The manufacturer shall provide three (3) certified copies of factory test reports as specified in Paragraph 1.03H.

PART 3 EXECUTION

3.01 MANUFACTURER'S REPRESENTATIVE

- A. Provide the services of a qualified factory-trained manufacturer's field engineer to assist the Contractor in installation and start-up of the equipment specified under this Section for a period of not less than two (2) working days, with not less than one working day per motor control center. The manufacturer's field engineer shall provide technical

direction and assistance to the Contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

- B. The Contractor shall provide three (3) copies of the manufacturer's field testing report.

3.02 FIELD ADJUSTING

- A. Adjust all circuit breakers, switches, access doors, operating handles for free mechanical and electrical operation as described in manufacturer's instructions.
- B. The Power Monitoring and Protective Relays shall be set in the field by a qualified representative of the manufacturer, retained by the Contractor, in accordance with settings designated in a coordinated study of the system by the Contractor. All such settings, including the application of arc flash labels, shall have been made and Approved by the Owner/Engineer, prior to energizing of the equipment.

3.03 FIELD TESTING

- A. The manufacturer's field engineer shall make all electrical field tests recommended by the manufacturer, and including the following tests;
 - 1. Verify tightness of all bolted connections by calibrated torque-wrench in accordance with manufacturer's published data.
 - 2. Confirm the correct application of manufacturer's recommended lubricants.
 - 3. Perform a contact resistance test.
 - 4. Perform an insulation-resistance test on all control wiring at 1000 volts dc. Disconnect all connections to solid-state equipment prior to testing.
 - 5. Perform an insulation-resistance test on all other wiring and current carrying parts at a minimum dc test voltage of 2500 volts dc, pole-to-pole, pole-to-ground, and across open poles. Minimum values shall not be less than 5,000 Megohms. In no case shall the manufacturer's maximum test voltages be exceeded.
- B. The tests shall adhere to manufacturer's testing recommendations for the proper testing methods and test voltage levels for each piece of equipment. Readings that fall below manufacturer's recommended values will not be acceptable and the Contractor shall be required to perform any necessary remedial action before the busing is energized. A data sheet shall be submitted to the Owner/Engineer for the MVMCC. The test report shall include the following equipment information:
 - 1. MVMCC Name and Number:
 - 2. MVMCC Manufacturer:
 - 3. MVMCC Nameplate Data:

- a. Volts:
 - b. Horizontal Bus Amps:
 - c. Main Switch Amps:
 - d. Insulation Test (measured):
 - 1) Phase A-B:
 - 2) Phase B-C:
 - 3) Phase C-A:
 - 4) Phase A-G:
 - 5) Phase B-G:
 - 6) Phase C-G:
 - e. Equipment disconnect during test:
 - f. Date of Test:
 - g. Tested by:
- C. Where test reports show unsatisfactory results, the Owner/Engineer may require the removal of all defective or suspected materials, equipment and/or apparatus, and their replacement with new items, all at no cost to the Owner. The Contractor shall bear all cost for any retesting.

3.04 MANUFACTURER'S CERTIFICATION

- A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted, including all settings designated in the Power System Study, and tested in accordance with the manufacturer's recommendations.
- B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification.

3.05 TRAINING

- A. Provide manufacturer's services for training of plant personnel in operation and maintenance of the equipment furnished under this Section.
- B. The training shall be for a period of not less than one (1) eight-hour day.
- C. The cost of training program to be conducted with Owner's personnel shall be included in the Contract Price. The training and instructions, insofar as practicable, shall be directly related to the system being supplied.
- D. Provide detailed O&M manuals to supplement the training course. The manuals shall include specific details of equipment supplied and operations specific to the project.
- E. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, motor starters, protective

devices, metering, and other major components.

- F. The Owner reserves the rights to videotape the training sessions for the Owner's use.

END OF SECTION



APPENDIX A

DIVISION 1

GENERAL REQUIREMENTS

SECTION 01300

SUBMITTALS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. This section describes the requirements for preparing and presenting submittals that are necessary for the execution of this contract. Requirements within the following subject areas are included:
1. Definitions.
 2. Procedures.
 3. Product Data.
 4. Shop drawings.
 5. Samples.
 6. Manufacturer's certificates.
 7. Miscellaneous submittals.
 8. Schedule of Values.
 9. Quality Control Documentation (Blank Copies of Report).

1.02 DEFINITIONS

- A. Product Data and Shop Drawing - General Definition
1. Drawings, diagrams, illustrations, brochures, schedules, bills of materials and other data prepared by the EARLY PROCUREMENT EQUIPMENT SUPPLIER (SUPPLIER), his subcontractors, suppliers or distributors, or equipment manufacturers and fabricators; illustrating the manufacture, fabrication, construction, or installation of the Work or a portion thereof.
- B. Shop Drawings
1. Assembly and fabrication drawings, bills of materials for items shop fabricated exclusively for this project. In addition, shop drawings should show fabrication details of each part, the assembly of each part and how each part and/or assembly is integrated into the project including existing parts or assemblies.

C. Manufacturer's Representative

1. Manufacturer's representative shall be from the manufacturer's plant with five (5) years of experience in the actual problems of manufacturing, installing, and operating the particular product. Sales representatives or agents of the manufacturer will not be acceptable.

D. Working Drawings

1. SUPPLIER prepared plans for temporary structures and facilities. Working drawings for elements of work that may affect the safety and health of persons or property will be certified by an engineer licensed in the State of Texas. Calculations, as necessary, will accompany working drawings.

E. Design Calculations

1. Whenever the SUPPLIER is required to submit design calculations as part of a submittal, such calculations shall bear the signature and seal of a professional engineer registered in the appropriate branch. ENGINEER reserves the right to request submittal by SUPPLIER of a hard copy of design calculations.

1.03 PROCEDURES

A. Electronic Submittal Procedures

1. All electronic submittals shall be transmitted in Portable Document Format (PDF) as generated by the Adobe Acrobat Professional Version 7.0 or higher.
2. It will be the SUPPLIER's responsibility to scan all necessary documents or convert previously received electronic files from vendors into pdf format before uploading the files to the specific designated project site. Scanned images must be at a readable resolution. For most documents, they should be scanned at 300 dots per inch (dpi). Optical character Recognition (OCR) capture must be performed on these images so that text can be searched and copied from the generated PDF file.
3. When it is not possible to make submittals electronically, SUPPLIER may deliver submittals to OWNER using conventional mail only after securing OWNER's written approval. When electronic submittals are not possible, hard copy submissions will be made as required in this section. Submittal of a transmittal page into the contract-specific Prolog site of Portal by SUPPLIER shall still be required for recordkeeping.
4. When electronic submittal is not possible and upon securing OWNER's written approval, SUPPLIER may submit hard copies of product data and shop drawings according to the following distribution list:
 - a. OWNER's designated Agent (if applicable): Three (3) copies.
 - b. OWNER (if a designated Agent reviews the submittals): One (1) copy.
 - c. ENGINEER: One (1) copy.

5. If regular mail delivery is approved by OWNER, the submittal transmittal form shall still be logged into the contract specific Contract and Project Management System (CPMS) by SUPPLIER for record keeping purposes.
6. All responses to a submittal by ENGINEER will be made electronically and no hard copies of the response will be sent to SUPPLIER.

B. Supplier's Responsibilities

1. Submit a list of specified submittals and identify the long lead items to the OWNER within five (5) calendar days of receipt of the Notice to Proceed (NTP).
2. Within 30 days after the pre-construction conference and at the same time that the initial critical path schedule is submitted, a schedule shall be submitted of the items of materials and equipment for which shop drawings are required by the specifications. For each required shop drawing, the date shall be given for intended submission of the drawing to ENGINEER for review and the date required for its return to avoid delay in any activity beyond the scheduled start date. Sufficient time shall be allowed for initial review, correction and resubmission, and final review of all shop drawings. In no case shall a schedule be acceptable which allows less than 21 days for each review by ENGINEER.
3. SUPPLIER to approve all submittals prior to submission.
4. SUPPLIER shall submit dimensional and layout drawings and product data, certified correct for construction, for review by the ENGINEER.
5. Submit shop drawings and product data in accordance with the approved submittal schedule. Also, submit shop drawings to the ENGINEER for review prior to their need in the Work, allowing sufficient time for the ENGINEER's review and the SUPPLIER response.
6. SUPPLIER shall make specific mention of those items that vary from the requirements of the Contract Documents in the letter of transmittal. The letter transmittal shall include the specification number, detail name/number, or plan sheet of the item being submitted.
7. Submit shop drawings and product data covering related items of equipment or material or integrated systems of equipment or material at the same time. Partial submissions will not be accepted.
8. All submittals, regardless of origin, shall be stamped with the approval of SUPPLIER and identified with the name and number of this contract, SUPPLIER name, and references to applicable specification paragraphs and Contract Drawings. Each submittal shall indicate the intended use of the item in the Work. When catalog pages are submitted, applicable items shall be clearly identified and inapplicable data crossed out. The current revision, issue number, and date shall be indicated on all drawings and other descriptive data.
9. SUPPLIER shall be solely responsible for the completeness of each submission. SUPPLIER stamp of approval is a representation to OWNER that SUPPLIER accepts sole responsibility for determining and verifying all quantities, dimensions, field construction criteria,

materials, catalog number, and similar data, and that SUPPLIER has reviewed and coordinated each submittal with the requirements of the Work and the Contract Documents.

10. SUPPLIER shall coordinate shop drawings and product data with drawings previously submitted, with drawings being prepared, and with drawings and data previously approved. All such coordination shall be indicated by reference.
11. SUPPLIER shall assign a sequential number to each submittal.
 - a. Assignment of numbers shall be by means of a letter prefix, a sequence number, a letter suffix to indicate resubmittals and a specification number. For example, submittal SD-012C-01300 is the third re-submittal of the twelfth Shop Drawing for the Project.
 - b. The sequence number shall be issued in chronological order. Resubmittals shall be followed by a letter of the alphabet to indicate the number of times a submittal has been resubmitted to the ENGINEER for processing. As an example, a shop drawing with the number SD-001 indicates that the submittal is the first shop drawing submitted for the project. Shop Drawing Number SD-002A indicates that the submittal is the second shop drawing submitted for and is being submitted for the second time. Acceptable prefixes for submittals are as follows:

i.	SD -Shop Drawing
ii.	PS – Project Schedule
iii.	RD – Record Data
iv.	OM – Operation and Maintenance Manual
 - c. Correct assignment of numbers is essential as different submittal types are processed in different ways. Some submittals received do not require that any response be given for the material. SUPPLIER and ENGINEER shall both maintain a log of submissions to allow the processing of SUPPLIER's submittals to be monitored. Logs will be reviewed periodically to determine that all submittals are received and processed.
 - d. Submittals shall be marked to show clearly the applicable sections of the specification and sheet number of drawings.
 - e. Submittals shall be accompanied by a Submittal Transmittal Form to be provided by the OWNER. A separate form shall be used for each specific item, class of material, equipment, and items specified in separate discrete sections, etc. for which a submittal is required. Submittals for various items shall be made with a single form when the items taken together constitute a manufacturer's package or are so functionally related that they should be.
12. SUPPLIER shall not deliver to the site, storage, or incorporate into the Work, any materials or equipment for which approved submittals have not been obtained.
13. If a submittal is returned to the SUPPLIER marked “NO EXCEPTIONS NOTED”, formal revision and resubmission shall not be required. SUPPLIER may proceed to perform submittal related Work.

14. If a submittal is returned marked “EXCEPTIONS NOTED”, SUPPLIER shall make the corrections on the submittal, but formal revision and resubmission shall not be required and the SUPPLIER shall proceed with the Work.
15. If a submittal is returned marked “RETURNED FOR CORRECTION,” the SUPPLIER shall revise it and resubmit to the OWNER for review. Resubmittal and a grade of “NO EXCEPTIONS NOTED” or “EXCEPTIONS NOTED” is required before the SUPPLIER may proceed with the Work, unless approved in writing by the OWNER. Resubmittal of portions of multi-page or multi-drawing submittals shall not be allowed. For example, if a Shop Drawing submittal consisting of 10 drawings contains one drawing noted as “RETURNED FOR CORRECTION”, the submittal as a whole is deemed “RETURNED FOR CORRECTION”, and all 10 drawings are required to be resubmitted.
16. If a submittal is returned marked “NOT ACCEPTABLE,” it shall mean either that the submitted material or product does not satisfy the Specification, the submittal is so incomplete that it cannot be reviewed, or it is a substitution request not in accordance with the General Conditions of the Contract. SUPPLIER shall prepare and deliver a new submittal to the ENGINEER for review.
17. Resubmittal of rejected portions of a previous submittal shall not be allowed. When resubmittals are needed, every change from a submittal to a resubmittal or from a resubmittal to a subsequent resubmittal shall be clearly identified and flagged on the resubmittal by SUPPLIER.
18. When resubmittals are needed, resubmittals shall be made within 30 days of the date on which documents to be modified or corrected were posted on CPMS by ENGINEER or its designated reviewer (electronic submittals) or of the postmark date of the letter returning the material (if a hard copy-type submittal was approved by OWNER), whichever is later. A time extension shall be considered by ENGINEER only if within the required number of days SUPPLIER submits an acceptable request for an extension of time, listing the reasons why the resubmittal cannot be completed within the stipulated time.
19. The need for more than one resubmittal, or any other delay in obtaining ENGINEER’s review of submittals, shall not entitle SUPPLIER to extension of the Contract Times unless delay of the Work is the direct result of a change in the Work authorized by a Change Order or failure of OWNER to review and return any submittal to SUPPLIER within the specified review period.
20. SUPPLIER shall not deliver to the site, store, or incorporate into the Work, any materials or equipment for which approved submittals have not been obtained.
21. When electronic submittals are not possible, hard copy submissions shall be made as required in this Section. Submittal of a transmittal form into the contract-specific web-based project management system by SUPPLIER shall still be required for record keeping.
22. SUPPLIER is responsible for frequent monitoring of the web-based documents and the submittal process status.

C. ENGINEER Responsibility

1. ENGINEER will conduct a thorough review within 21 calendar days after its receipt in CPMS so as not to create delay. This review will be for general conformance, subject to the requirements of the Contract Documents, and will be an effort to assist the SUPPLIER to discover errors and omissions in submittals. ENGINEER review, approval, or other appropriate action regarding SUPPLIER submissions will be only to check conformity with the design concept of the Project and for compliance with the information contained in the Contract Documents and shall not extend to means, methods, techniques, sequences or procedures of construction (except where a specific means, method, technique, sequence or procedure of construction is indicated in or required by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate component item will not indicate approval of the assembly into which the item is functionally integrated. SUPPLIER shall make corrections required by ENGINEER, and shall return the required number of corrected copies of Shop Drawings to the OWNER. SUPPLIER may be required to resubmit, as required, revised Shop Drawings or Samples for further review and approval. SUPPLIER shall direct specific attention in writing to any new revisions not specified by SUPPLIER on previous SUPPLIER submissions.
2. ENGINEER review does not relieve the SUPPLIER of the obligation and responsibility to coordinate the Work and plan the details of the Work.
3. The OWNER reserves the right to require written confirmation from the SUPPLIER that the comments placed on submittals stamped "Exceptions Noted" will actually be followed.
4. Review by the ENGINEER will not be construed as relieving the SUPPLIER of the responsibility for the accuracy, proper fit, functioning, or performance of the Work.

1.04 PRODUCT DATA

- A. Product data, including materials reproduced from manufacturer's product catalogs will not be larger than 8 ½" by 11" in size.
- B. Catalog data will be explicit with regards to the name of the manufacturer and to the details of the products being furnished. It will also be complete enough to enable the OWNER to determine that the products being submitted conform to the requirements of the Specifications.
- C. For submittals with more than one style or size of a product on a sheet, the SUPPLIER will clearly indicate which product is being submitted for review.
- D. SUPPLIER will provide electronic submittals in .pdf format of all product data to the OWNER. Files shall be readable using Adobe Acrobat Reader Version 7.0.

1.05 SHOP DRAWINGS

- A. SUPPLIER shall reasonably check and verify all field measurements and will submit to the OWNER for review and approval. These shop drawings will bear a stamp from the SUPPLIER that indicates that the SUPPLIER has reviewed the shop drawings and that the submittal is complete and in compliance with Contract Documents.

- B. Substitute and “Or Approved Equal” Items: Meet requirements of Paragraph 5.12 of the General Conditions.
- C. SUPPLIER will submit detailed drawings and descriptions of proposed deviations from details or component arrangement indicated on the Plans.
- D. Single line drawings will not be acceptable. Copies of the Plans will not be accepted for submission as drawings, nor will catalog numbers alone of materials or equipment.
- E. SUPPLIER will submit electronic copies in .pdf format of each shop drawing to the OWNER for review. Files shall be readable using Adobe Acrobat Reader 7.0.

1.06 SAMPLES

- A. SUPPLIER will furnish samples of items and materials as required. Samples shall be submitted to the OWNER in duplicate. Each sample will be properly labeled and identified by providing the following:
 - 1. Date.
 - 2. Job name for which it is offered.
 - 3. Specification section and paragraph.
 - 4. SUPPLIER’s name.
 - 5. Supplier and trade name.
 - 6. Other data indicating conformance to the Specifications.
 - 7. Color charts or samples with manufacturer’s number.

1.07 MANUFACTURER’S CERTIFICATES AND AFFIDAVITS

- A. Where specified in the Contract Documents that a certificate and affidavit shall be submitted to the OWNER for review of a particular product, or component of a product, such submittals shall be made in accordance with the following:
 - 1. A certificate submitted for a product, or component of a product, indicates test results proving that product, or component of a product, meets the requirements of the standard specified in the Contract Documents.
 - 2. An affidavit consisting of a sworn statement by an official of the company manufacturing the product indicating that the information on the certificate is true and accurate shall accompany the certificate.
 - 3. A statement from the SUPPLIER, or his subcontractors, suppliers, or other agent which indicates that a particular item of equipment, product, or component of a product, meets the

requirements of the Contract Documents shall not be considered a certificate and will not be approved.

1.08 MANUFACTURER'S REPRESENTATIVE

- A. SUPPLIER will include in the Contract Price the cost of furnishing competent and experienced manufacturer's representatives who will represent the manufacturer on products finished and to assist the SUPPLIER to install the products in conformity with the Contract Documents.

1.09 MISCELLANEOUS SUBMISSIONS

- A. Provide the following submissions electronically using the designated project website (to be defined during the initial construction meeting). Files shall be readable using Adobe Acrobat Reader 7.0. Provide hard copies as requested by OWNER.

1. Work plans.
2. Quality Control (QC) Plan.
 - (i) QC Plan must be submitted and approved prior to commencing Work.
3. Accident reports.
4. Inspection and test reports.
5. Guarantees and warranties.
6. Operation and Maintenance Manuals.
7. Course of Action Plan (Fuel Spill or Other Substances).
 - (i) SUPPLIER must submit the Course of Action Plan (Fuel Spill or Other Substances) to the OWNER prior to start of construction.
 - (ii) With regard to the accidental spill of fuel, the Plan must address the procedures required by applicable regulations and laws.
8. SUPPLIER's Safety and Health Plan.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

SECTION 01600

MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. This Section describes the requirements for material and equipment that are necessary for the execution of this contract. Requirements within the following subject areas are included:
1. Products.
 2. Preparation for shipment.
 3. Packaging and delivery of spare parts and tools.
 4. Shipment and handling.
 5. Inspection
 6. Storage and protection
 7. Inventory control.
 8. Product options.
 9. Substitutions.
 10. Systems demonstration.
 11. Warranties.

1.02 PRODUCTS

- A. The term "products" means new material, machinery, components, equipment, fixtures, and systems forming the Work. It does not include machinery and equipment used for preparation, fabrication, conveying, and erection of the Work. Products may also include existing materials or components required for reuse.
- B. Do not use materials and equipment salvaged from this project, except as specifically permitted by the Plans.
- C. Materials and equipment to be provided under this contract shall be standard catalogue products of manufacturers regularly engaged in the manufacture of the products and shall duplicate material and equipment in satisfactory service for at least two (2) years.
- D. Material and equipment shall meet the requirements of the Contract and shall be suitable for the installation for which they are planned. Where two (2) or more of the same equipment class are furnished, the equipment shall be from the same manufacturer and shall be interchangeable. Materials and equipment shall be new and free from defects.

- E. Materials and equipment shall be installed in accordance with the requirements of the Plans and approved recommendations of the manufacturer.

1.03 PREPARATION FOR SHIPMENT

- A. When practical, equipment shall be factory assembled. The equipment parts and assemblies that are shipped unassembled shall be furnished with an assembly plan and instructions. The separate parts and assemblies will be match-marked or tagged in a manner to facilitate field assembly.
- B. Generally, machined and unpainted parts subject to damage by the elements shall be protected with an application of a strippable protective coating.
- C. Equipment shall be packaged or crated in a manner that will provide protection from damage during shipping, handling, and storage.
- D. The outside of the package or crate shall be adequately marked or tagged to indicate its contents by name and equipment number, if applicable, approximate weight, special handling precautions, and recommended storage procedures.

1.04 PACKAGING AND DELIVERY OF SPARE PARTS AND SPECIAL TOOLS

- A. Spare parts and special tools shall be properly marked to identify the associated equipment by name, equipment type, and part number. Parts shall be packaged in a manner for protection against damage from the elements during shipping, handling, and storage. Spare parts and special tools shall be shipped in boxes that shall be marked to indicate the contents. Delivery of spare parts and special tools shall be made prior to the time the associated equipment is scheduled for its initial test run.

1.05 SHIPMENT AND HANDLING

- A. Shipments shall be addressed to the CONTRACTOR who will be responsible for their receipt, unloading, handling, and storage at the site. The OWNER will not accept deliveries on behalf of the CONTRACTOR or his subcontractors nor assume responsibility for the security of the materials, equipment, or supplies delivered to the site.
- B. CONTRACTOR will transport and handle products in accordance with manufacturer's instructions.
- C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.06 INSPECTION

- A. Immediately upon receipt of equipment and materials at the job site, the CONTRACTOR will inspect for completeness and any evidence of damage. Should there appear to be any damage, the CONTRACTOR will immediately notify the Construction Observer/Inspector (COI).

CONTRACTOR will then be responsible for notifying the manufacturers and the transportation company of the extent of the damage. If the item or items require replacing, the CONTRACTOR will take the necessary measures for replacement.

1.07 STORAGE AND PROTECTION

- A. CONTRACTOR will store products in accordance with the manufacturer's instructions, with seals and labels intact and legible. Sensitive items will be stored in weather-tight enclosures; with the humidity and temperature maintained within the ranges recommended by the manufacturer.
- B. For exterior storage of fabricated products, the CONTRACTOR will place on sloped supports above ground. Products that are subject to deterioration will be covered with an impervious sheet and will be supplied with adequate ventilation to avoid condensation.
- C. CONTRACTOR will store loose granular materials on solid surfaces in a well-drained area in such a manner as to prevent mixing.
- D. CONTRACTOR shall arrange to provide access for inspection. He will also periodically inspect to ensure products are undamaged and are maintained under required conditions.

1.08 INVENTORY CONTROL

- A. Equipment and materials shall be stored in a manner to provide easy access for inspection and inventory control. CONTRACTOR shall keep a running account of all materials in storage to facilitate inspection and to estimate progress payments for materials delivered but not installed in the Work.

1.09 PRODUCT OPTIONS

- A. CONTRACTOR has the following options in providing products specified for the Work:
 - 1. Products specified by reference standards or by description only: CONTRACTOR may provide any product meeting the standard.
 - 2. Products specified by naming one or more manufacturers: CONTRACTOR may provide the product from the named manufacturer or he may submit a request for substitution for any manufacturer not specifically named.

1.10 SUBSTITUTIONS

- A. Only after execution of the Contract will the OWNER consider requests from the CONTRACTOR for substitutions. Substitutions will be considered only when a product becomes unavailable due to no fault of the CONTRACTOR or is shown to be superior to the specified product.

- B. CONTRACTOR will document each request with complete data substantiating compliance of proposed substitution with the Contract Documents. Each request constitutes a declaration from the CONTRACTOR that:
 - 1. CONTRACTOR has investigated the proposed product and determined that it meets or exceeds, in all respects, the specified product.
 - 2. CONTRACTOR will provide the same warranty for substitution as for the specified product.
 - 3. CONTRACTOR will coordinate installation and make all other changes, which may be required for the Work to be complete in all respects.
 - 4. CONTRACTOR waives claims for additional costs and/or time, which may subsequently become apparent.
- C. Substitutions will not be considered when they are indicated or implied on shop drawings or product data submittals without a separate written request, or when acceptance will require substantial revision of the Contract Documents.
- D. OWNER will determine acceptability of proposed substitution, and will notify CONTRACTOR of acceptance or rejection in writing within a reasonable period of time.
- E. Only one request for substitution will be considered for each product. When substitution is not accepted, the CONTRACTOR will provide the specified product.

1.11 SYSTEMS DEMONSTRATION

- A. Prior to final inspection, demonstrate operation of each system to the OWNER.
- B. CONTRACTOR will instruct the OWNER's personnel in operation, adjustment, and maintenance of equipment and systems, using the operation and maintenance data as the basis of instruction.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

SECTION 01640

MANUFACTURER'S FIELD SERVICES

PART 1 GENERAL

1.01 SCOPE

This section shall govern the requirements established for MANUFACTURER'S field services associated with the installation of equipment.

1.02 RELATED WORK

- A. Section 01300 – Submittals
- B. Section 01600 – Material and Equipment
- C. Section 01752 – Facility Start Up/Commissioning Requirements

1.03 DESCRIPTION OF WORK

CONTRACTOR shall arrange for and coordinate the MANUFACTURER'S services as specified below.

1.04 SUBMITTALS

- A. Training Plan (Pre Start Up and Post Start Up):
 - 1. Submit not less than 21 calendar days prior to start of equipment testing and revise as necessary for OWNER's acceptance.
 - 2. Submit MANUFACTURER'S tentative training schedule, training plan, and contact person not less than 60 calendar days prior to commencement of any training.
 - a. MANUFACTURER'S proposed Training Plan shall include the elements presented in the Outline of Instruction Training Plan specified herein. Specific components and procedures shall be identified in the proposed Training Plan. Hands-on demonstrations planned for the instruction shall be described in the Training Plan. The MANUFACTURER shall indicate the estimated duration of each segment of the Training Plan.
 - b. Outline of Instruction Training Plan:
 - i. Equipment Description and Purpose
 - ii. Equipment operation
 - iii. Detailed component description
 - iv. Equipment preventative maintenance (PM)
 - v. Equipment troubleshooting
 - vi. Equipment corrective maintenance

3. Provide complete training materials, to include operation and maintenance data as required in this section to be retained by each trainee.
- B. Quality Control Submittals:
1. MANUFACTURER'S Certificate of Proper Installation:
 - a. When specified in the individual equipment specification sections or Equipment Schedule, submit certificate certifying:
 - i. The product or system has been installed in accordance with the MANUFACTURER'S recommendations, inspected by a MANUFACTURER'S authorized representative, and serviced with the proper lubricants.
 - ii. Necessary safety equipment has been properly installed.
 - iii. Electrical and mechanical connections have been made meeting quality and safety standards as required.
 - iv. Free from undue stress imposed by exterior connections or loads.
 - v. Proper adjustments have been made and the product or system is ready for testing, facilities startup, operational test, and operation.
 - b. Submit MANUFACTURER'S Certificated of Proper Installation Form at end of this Specification.
 4. Certificate of Successful Equipment Testing: Prepare and submit where specified in individual equipment specification sections or Equipment Schedule, and upon completion of successful testing of respective equipment by the CONTRACTOR. See Certificate of Successful Equipment Testing Form at end of this Specification.
 5. Certificate of Successful Equipment System, Subsystem or Component, Start Up Testing including Functional and Performance Tests: Prepare and submit where specified in individual equipment specification sections or Equipment Schedule, and upon completion of successful Start Up testing of respective equipment system, subsystem or component by the CONTRACTOR. See Certificate of Successful Equipment System, subsystem or component Start Up Testing Form at end of this Specification.
 6. Certificate of qualification of MANUFACTURER'S representative.

1.05 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

Authorized representative of the MANUFACTURER, Certified by MANUFACTURER, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, system, subsystem, or component. Representative subject to acceptance by OWNER. No substitute representatives will be allowed unless prior written approval by OWNER has been given.

1.06 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

- A. Where MANUFACTURER'S field services are specified, furnish MANUFACTURER'S representative qualified to provide these services. Where time is necessary in excess of that

stated in the Contract Documents for MANUFACTURER'S field services, additional time required to perform the specified services shall be considered incidental work.

- B. Coordinate and Schedule MANUFACTURER'S field services to avoid conflicting with other field testing or other MANUFACTURER'S field services. Determine that all conditions necessary to allow successful testing have been met before scheduling field services.
- C. Only those days of service approved by OWNER will be credited to fulfill the specified minimum services.
- D. If specified, MANUFACTURER'S field services shall include as a minimum:
 - 1. Assistance during installation to include observation, guidance, instruction of CONTRACTOR's assembly, erection, installation or application procedures.
 - 2. Inspection, checking, and adjustment as required for equipment to function as warranted by MANUFACTURER and necessary to provide written approval of installation.
 - 3. Revisiting the site as required to correct problems and until installation and operation are acceptable to OWNER.
 - 4. Resolution of assembly or installation problems attributable to, or associated with, respective MANUFACTURER'S products, equipment, system, subsystem and components.
 - 5. Assistance during testing and Start Up demonstration, and until product acceptance by the OWNER.
 - 6. Training of OWNER's personnel in the operation and maintenance of respective products as required herein.
 - 7. Completion of MANUFACTURER'S Certificate of Proper Installation and applicable certificates of Successful Equipment Testing and Successful Equipment System, Subsystem or Component Start Up Testing, as required, including functional and performance tests service. (Forms at the end of this Specification)

1.07 TRAINING SCHEDULE

- A. List specified equipment, system, subsystem, and component with respective MANUFACTURERS that require training services of MANUFACTURER'S representatives and show:
 - 1. Estimated dates for installation completion.
 - 2. Estimate training dates to allow for multiple sessions when several shifts are involved.

3. Use Equipment Schedule as guidance and revise as needed to meet individual equipment specifications or MANUFACTURER'S requirements for the preparation of estimated dates. Dates must be included as milestones on general project schedule, and must be coordinated as to allow completion of the project including Start Up Phase by Substantial Completion Date.
- B. Adjust training schedule to ensure training of appropriate personnel as deemed necessary by OWNER and to allow full participation by MANUFACTURER'S representatives. Adjust schedule for interruptions in operability of equipment.
 - C. Training shall not proceed until all individual equipment, systems, subsystems or components have been installed and approved by the MANUFACTURER and completed the testing requirements indicated in specification 01650.
 - D. Pre Start Up Training:
 1. Coordinate and furnish classroom training sessions with the OWNER's operating personnel and MANUFACTURER'S representatives.
 2. Conduct training prior to as defined in Specification Section 01752 – Facility Start-up/Commissioning Requirements.
 3. Provide Draft O&M Manuals.
 - E. Post Start Up Training:
 1. Coordinate and furnish on-site training sessions with the OWNER's operating personnel and MANUFACTURER'S representatives.
 2. Conduct after Facility Start Up, but prior to Operational Testing of the equipment as defined in Specification Section 01752.
 3. Provide Final O&M Manuals.

1.08 TRAINING OWNER'S PERSONNEL

- A. Provide trained, articulate personnel acceptable to the OWNER to coordinate and expedite training, to be present during training coordination meetings with OWNER and familiar with operation and maintenance manual information.
- B. MANUFACTURER'S Representative shall provide the number of days of training for equipment as indicated in the Equipment Schedule section. Operator training days shall be in addition to MANUFACTURER'S field services required as indicated in the Equipment Schedule and submittals sections.
 1. All training will be performed during the operating staff's normal business hours and at other times requested and approved by the OWNER.
- C. MANUFACTURER'S representatives to provide detailed training to OWNER's personnel on operation and maintenance of specified product (equipment, system, subsystem, and

component) and as required in applicable Contract Documents. This includes operation, disassembly, and assembly of major equipment items, start up, shutdown, safety concerns, troubleshooting, installation, alignment, and recommended corrective and preventative maintenance procedures for all equipment.

1. Training services include Pre Start Up classroom instruction and Post Start Up onsite hands-on instruction.
2. MANUFACTURER'S Representative shall be familiar with system operation and maintenance requirements for specified equipment, system, subsystem, or component.

D. Taping of Training Sessions: MANUFACTURER to videotape Pre Start and Post Start Up training sessions and furnish to the OWNER.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

SAN ANTONIO WATER SYSTEM
EQPT TAG NO.: _____
PROJECT NO.: _____

EQPT SERIAL NO.: _____
EQPT/SYSTEM: _____
SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

- Installed in accordance with MANUFACTURER'S recommendations.
- Inspected, checked, and adjusted.
- Serviced with proper initial lubricants.
- Electrical and mechanical connections meet quality and safety standards.
- All applicable safety equipment has been properly installed.

Comments: _____

I, the undersigned MANUFACTURER'S Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____

Manufacturer: _____

By MANUFACTURER'S Authorized Representative: _____
(Print Name/Authorized Signature)

CERTIFICATE OF SUCCESSFUL EQUIPMENT TESTING

SAN ANTONIO WATER SYSTEM
EQPT TAG NO.: _____
PROJECT NO.: _____

EQPT SERIAL NO.: _____
EQPT/SYSTEM: _____
SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

- Serviced for proper operation, efficiency, and capacity.
- Field adjusted for secure satisfactory operation.
- Tested continuously under actual or simulated operation conditions.
- Tested over the full range of speed and pressure.
- Tested at every level of control.

Comments: _____

I, the undersigned Contractor's Representative, hereby certify that I am (i) a duly authorized representative of the contractor, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____

Contractor: _____

By Manufacturer/Supplier Authorized Representative: _____
(Print Name/Authorized Signature)

By Contractor's Authorized Representative: _____
(Print Name/Authorized Signature)

SECTION 01730

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 DEFINITIONS

- A. Maintenance Operation: As used in the Maintenance Summary Form, attached to this specification, maintenance operation is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.
- B. System and Subsystem: Refer to Section 01652 – System Operation and Section 01752 – Facility Startup and Commissioning Requirements.

1.02 QUALITY ASSURANCE

- A. Manuals for equipment and systems shall be prepared by equipment manufacturer or system Supplier.

1.03 SEQUENCING AND SCHEDULING

- A. Manual Outline: Submit detailed outline of each manual prior to preparation of Preliminary Manuals.
- B. Manuals for Equipment and Systems:
 - 1. Preliminary Manuals: Submit prior to shipment date for equipment, system, subsystem, or component. Include copy of warranties, bonds, and service agreements if specified.
 - 2. Final Manuals: Submit not less than 30 days prior to equipment or system field testing or startup.
- C. Manuals for Materials and Finishes:
 - 1. Preliminary Manuals: Submit at least 30 days prior to request for final inspection.
 - 2. Final Manuals: Submit within 10 days after final inspection.

1.04 GENERAL

- A. Furnish for each item of equipment or system as specified in the individual Specification sections.
- B. Prepare data for use by OWNER's personnel in the form of an instructional manual in both paper format and on electronic media. Data for electronic media shall be provided to OWNER on optical compact disc.

C. Manual Format:

1. Size: 8-1/2 inches x 11 inches.
2. Paper: 20-pound minimum, white for typed pages.
3. Text: Manufacturer's printed data, or neatly typewritten.
4. Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.
5. Provide flyleaf for each separate product or each piece of operating equipment, with typed description of product and major component parts of equipment and provide with heavy section dividers with numbered plastic index tabs.
6. Provide each manual with title page, and typed table of contents with consecutive page numbers. Place contents of entire set, identified by volume number, in each binder.
7. Cover: Identify each volume with typed or printed title "OPERATION AND MAINTENANCE MANUAL, VOLUME NO. – OF –", if applicable, and list:
 - a. Project title.
 - b. Designate the system or equipment for which it is intended.
 - c. Identity of separate structure as applicable.
 - d. Identity of equipment number and Specification section.
8. Assemble and bind material in same order as specified, as much as possible.
9. Final copy shall not have fax copies or photocopies of manufacturer information. Each manual shall have original materials.
10. Binders:
 - a. Preliminary Manuals: Heavy paper covers.
 - b. Final Manuals: Commercial quality, substantial, permanent, three-ring binders with durable, cleanable, plastic binders.
11. Table of contents neatly typewritten, arranged in a systematic order:
 - a. CONTRACTOR, name of responsible principal, address, and telephone number.
 - b. List of each product required to be included, indexed to content of each volume.

- c. List with Each Product: Name, address, and telephone number of Subcontractor, Supplier, installer, and maintenance contractor, as appropriate.
 - i. Identify area of responsibility of each.
 - ii. Provide local source of supply for parts and replacement.
 - d. Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.
12. Product Data:
- a. Include only those sheets that are pertinent to specific product.
 - b. Clearly annotate each sheet to:
 - i. Identify specific product or part installed.
 - ii. Identify data applicable to installation.
 - iii. Delete references to inapplicable information.
13. Drawings: Supplement product data with Drawings as necessary to clearly illustrate:
- a. Relations of component parts of equipment and systems.
 - b. Control and flow diagrams.
 - c. Coordinate drawings with Project record documents to assure correct illustration of completed installation.
 - d. Do not use Project record documents as maintenance manual drawings.
 - e. Provide reinforced punched binder tab, bind in with text.
 - f. Reduced to 8-1/2 inches x 11 inches, or 11 inches x 17 inches folded to 8-1/2 inches x 11 inches.
 - g. Where reduction is impractical, fold and place in 8-1/2-inch x 11-inch envelopes bound in text.
 - h. Identify Specification section and product on Drawings and envelopes.
14. Instructions and Procedures: Within text, as required to supplement product data.

- a. Handling, storage, maintenance during storage, assembly, erection, installation, adjusting, testing, operating, shutdown in emergency, troubleshooting, maintenance, interface, and as may otherwise be required.
 - b. Organize in a consistent format under separate heading for each different procedure.
 - c. Provide a logical sequence of instructions for each procedure.
 - d. Provide information sheet for OWNER's personnel, including:
 - i. Proper procedures in the event of failure.
 - ii. Instances that might affect the validity of warranties or Bonds.
15. Warranties, Bonds, and Service Agreements.
- D. Electronic Format: All electronic submittals shall be transmitted in Portable Document Format (PDF) as generated by the Adobe Acrobat Professional Version 7.0 or higher. The PDF file(s) shall be fully indexed using the Table of Contents, searchable with thumbnails generated.
- 1. File names shall use the “eight dot three” convention (XXXXXX_YY.pdf), where X is the five digit number corresponding to the specification section, and YY is a sequential ID number. The ID number is to track multiple O&M manuals per specification section. If technical problems require breaking of the submittal into multiple files then a letter extension shall be added to the end of the filename (example: 13100.01A.PDF). The number of files shall be kept to a minimum.
 - 2. Scanned images must be at a readable resolution. For most documents, they should be scanned at 300 dots per inch (dpi). Optical Character Recognition (OCR) capture must be performed on these images. OCR settings shall be performed with the “original image with hidden text” option in Adobe Acrobat Exchange.
 - 3. One PDF document (PDF file) shall be created for each equipment service manual. The entire manual shall be converted to a single .PDF file via scanning or other method of conversion. Drawings or other graphics shall also be converted to .PDF format and included into the single PDF document. Pages that must be viewed in landscape format shall be rotated to the appropriate position for easy reading on screen. Word searches of the PDF document must operate successfully.
 - 4. The PDF documents shall have a bookmark created in the navigation frame for each major entry (“Section” or “Chapter”) in the Table of Contents. Thumbnails shall be generated for each page or graphic in the PDF file.
 - 5. Labeling: As a minimum requirement, include the following labeling on all final O&M materials.

- a. Manufacturer Name
- b. Equipment name and/or O&M title spelled out in complete words. (example: “Operations and Maintenance Manual” “Oscillating Wastewater Converter”)
- c. Specification Section No.
- d. Project Name

1.05 SUBMITTAL PROCEDURE

A. Sequencing and Scheduling

- 1. Manual Outline: Submit to OWNER detailed outline of each manual prior to preparation of Preliminary Manuals.
- 2. Manuals for Equipment and Systems
 - a. Preliminary Manuals: Submit prior to shipment date for equipment, system, subsystem, or component. Include copy of warranties, Bonds, and service agreements if specified.
 - b. Final Manuals: Submit not less than 30 days prior to equipment or system field testing or startup.
- 3. Manuals for Materials and Finishes
 - a. Preliminary Manuals: Submit at least 30 days prior to request for final inspection.
 - b. Final Manuals: Submit within 10 days after final inspection.

B. Preliminary Manuals

- 1. Submittal Procedure: In accordance with Section 01300 – Submittals.
- 2. If Accepted submit six (6) hard copies of Final Manual.
- 3. If Rejected:
 - a. Follow procedure as outlined in Section 01300 – Submittals.

C. Final Manuals:

- 1. If different than accepted Preliminary Manuals, submit:
 - a. Two (2) copies of any necessary supplemental material, including revised table of contents.
 - b. Instructions for insertion of supplemental material in unreturned sets.

2. If Final Manuals are acceptable, CONTRACTOR will be so notified as outlined in Section 01300 – Submittals.
3. If rejected, and at OWNER's option:
 - a. Follow procedure as outlined in Section 01300 – Submittals.

1.02 MANUALS FOR EQUIPMENT AND SYSTEMS

- A. Content for Each Unit (or Common Units) and System:
 1. Description of unit and component parts, including controls, accessories, and appurtenances:
 - a. Function, normal operating characteristics, and limiting conditions.
 - b. Performance curves, engineering data, nameplate data, and tests.
 - c. Complete nomenclature and commercial number of replaceable parts.
 2. Operating Procedures:
 - a. Startup, break-in, routine, and normal operating instructions.
 - b. Test procedures and results of factory tests where required.
 - c. Regulation, control, stopping, and emergency instructions.
 - d. Description of operation sequence by control manufacturer.
 - e. Shutdown instructions for both short and extended duration.
 - f. Summer and winter operating instructions, as applicable.
 - g. Safety precautions.
 - h. Special operating instructions.
 - i. Installation instructions.
 3. Maintenance and Overhaul Procedures:
 - a. Routine operations.
 - b. Guide to troubleshooting.
 - c. Disassembly, removal, repair, reinstallation, and reassemble.
 4. Installation Instructions: Including alignment, adjusting, calibrating, and checking.

5. Original manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.
6. Spare parts ordering instructions.
7. Where applicable, identify installed spares and other provisions for future work (e.g., reserved panel space, unused components, wiring, and terminals).
8. Manufacturer's printed operating and maintenance instructions.
9. As-installed, color-coded piping diagrams.
10. Charts of valve tag numbers, with the location and function of each valve.

B. Maintenance Summary:

1. Compile an individual Maintenance Summary for each applicable equipment item, respective unit or system, and for components or sub-units.
2. Format:
 - a. Use Maintenance Summary Form bound with this section, or an electronic facsimile of such.
 - b. Each Maintenance Summary may take as many pages as required.
 - c. Use only 8-1/2-inch x 11-inch size paper.
 - d. Complete using typewriter or electronic printing.
3. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.
4. Recommended Spare Parts:
 - a. Data to be consistent with manufacturer's Bill of Materials/Parts List furnished in O&M manuals.
 - b. "Unit" is the unit of measure for ordering the part.
 - c. "Quantity" is the number of units recommended.
 - d. "Unit Cost" is the current purchase price.

C. Content for Each Electric or Electronic Item or System:

1. Description of Unit and Component Parts:
 - a. Function, normal operating characteristics, and limiting conditions.

- b. Performance curves, engineering data, nameplate data, and tests.
 - c. Complete nomenclature and commercial number of replaceable parts.
 - d. Interconnection wiring diagrams, including all control and lighting systems.
2. Circuit Directories of Panel Boards:
 - a. Electrical service.
 - b. Controls.
 - c. Communications.
 3. List of electrical relay settings, and control and alarm contact settings.
 4. Electrical interconnection wiring diagram, including control and lighting systems.
 5. As-installed control diagrams by control manufacturer.
 6. Operating Procedures:
 - a. Routine and normal operating instructions.
 - b. Sequences required.
 - c. Safety precautions.
 - d. Special operating instructions.
 7. Maintenance Procedures:
 - a. Routine operations.
 - b. Guide to troubleshooting.
 - c. Adjustment and checking.
 - d. List of relay settings, control and alarm contact settings.
 8. Manufacturer's printed operating and maintenance instructions.
 9. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.

1.07 MANUALS FOR MATERIALS AND FINISHES

A. Content for Architectural Products, Applied Materials, and Finishes:

1. Manufacturer's data, giving full information on products:

- a. Catalog number, size, and composition.
- b. Color and texture designations.
- c. Information required for reordering special-manufactured products.
- 2. Instructions for Care and Maintenance:
 - a. Manufacturer's recommendation for types of cleaning agents and methods.
 - b. Cautions against cleaning agents and methods that are detrimental to product.
 - c. Recommended schedule for cleaning and maintenance.
- B. Content for Moisture Protection and Weather Exposed Products:
 - 1. Manufacturer's data, giving full information on products:
 - a. Applicable standards.
 - b. Chemical composition.
 - c. Details of installation.
 - 2. Instructions for inspections, maintenance, and repair.

1.08 SUPPLEMENTS

- A. The supplements listed below, following “END OF SECTION”, are part of this Specification.
 - 1. Forms: Maintenance Summary Form.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

MAINTENANCE SUMMARY FORM

PROJECT: _____ CONTRACT NO.: _____

1. EQUIPMENT ITEM _____

2. MANUFACTURER _____

3. EQUIPMENT/TAG NUMBER(S) _____

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS) _____

5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____

6. MANUFACTURER'S LOCAL REPRESENTATIVE _____

a. Name__ Telephone No. _____

b. Address _____

7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	Frequency	Lubricant (If Applicable)
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

SECTION 01752

FACILITY START UP COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE

- A. This section covers starting of systems for all items of mechanical, electrical, and control equipment. Additional requirements may be specified in individual equipment section.
- B. Procedures and actions required of the CONTRACTOR, which are necessary to achieve a Letter of Substantial Completion.
 - 1. Pre Start Up (Construction Phase)
 - a. Factory Tests
 - b. Field Test
 - c. Test Log Submittals
 - 2. System Start Up
 - a. Functional Tests
 - b. Performance Tests
- C. Procedures and actions required of the CONTRACTOR, which are necessary to achieve a Memo of Final Acceptance.
 - 1. Operational Test

1.02 RELATED WORK

- A. Section 01300 – Submittals
- B. Section 01600 – Material and Equipment
- C. Section 01640 – Manufacturer’s Field Services

1.03 DEFINITIONS

- A. System: The overall process, or a portion thereof, that performs a specific function. A system may consist of the entire facility or two (2) or more subsystems as well as two (2) or more types of equipment or components.

- B. Pre Start Up: The period of time of unspecified duration during construction and installation activities which the CONTRACTOR, with assistance from MANUFACTURER's Representatives, performs the following sequence:
1. Finishes construction work so that the Project has reached a tentative state of Substantial Completion pending completion of the System Start Up.
 2. MANUFACTURER's Field Services
 - a. Equipment and Pre Start Up Assistance
 - b. Installation and Equipment Testing Certifications
 - c. Pre Start Up Training
- C. System Start Up: A period of time of specified duration, following the Pre-Start Up Period, during which the CONTRACTOR initiates process flow through the facility and operates the facility without exceeding specified downtime limitations, to prove the functional integrity of the mechanical and electrical equipment and components; the control interfaces of the respective equipment; and components comprising the facility, as evidence of Substantial Completion. The following test activities must be executed by the CONTRACTOR with assistance from the MANUFACTURER's Representative as needed.
1. Functional Tests: Test or tests performed by the CONTRACTOR in the presence of the OWNER to demonstrate that installed equipment, system, subsystem or components meet MANUFACTURER's installation and adjustment requirements; and other requirements specified including, but not limited to: noise, vibration, alignment, speed, proper electrical and mechanical connections, thrust restraint, proper rotation, and initial servicing.
 2. Performance Test: A test performed by the CONTRACTOR in the presence of the OWNER and after all required functional tests specified, to demonstrate and confirm that the equipment, system, subsystem or components meet the specified performance requirements.
 3. MANUFACTURER's Field Services
 - a. Equipment and System Start Up Assistance
 - b. Equipment, System, Subsystem, or Component Start Up Testing Certification.
 - c. Post Start Up Training
- D. Operational Test: A test of specified duration, performed by the OWNER with the assistance of the CONTRACTOR after all System Start Up testing has been completed. The equipment, system, subsystem, or component shall operate continuously without any malfunctions.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.01 DESCRIPTION OF WORK

- A. All items of mechanical and electrical equipment shall be tested for proper operation, efficiency, and capacity. All required adjustments, tests, operation checks, and other Pre Start Up activity shall be provided.

3.02 PRE START UP (CONSTRUCTION PHASE)

A. FACTORY TESTS

1. All items of equipment so specified shall be tested at the point of MANUFACTURER's facility at the CONTRACTOR's expense. Submittals shall in accordance with Section 01300 – Submittals.
2. Coordinate with the OWNER and ENGINEER for factory test schedule, if witness testing of equipment is specified in individual specification of the equipment.
3. Equipment shall not be shipped until the ENGINEER has reviewed the test results and notified the CONTRACTOR in writing that the equipment is acceptable for shipment. Such acceptance, however, shall not be considered as final acceptance, which will only be made on the basis of the test results of the equipment after installation.

B. FIELD TESTS

1. All items of mechanical, electrical, and control equipment shall be tested by the CONTRACTOR after installation for proper operation, efficiency, and capacity. CONTRACTOR's test operation of each piece of equipment shall continue for not less than eight (8) hours without interruption. All moving parts of equipment and machinery shall be carefully tested for operation, and adjusted so all parts move freely and function to secure satisfactory operation. All parts shall operate satisfactorily in all respects, under continuous full load and in accordance with the specified requirements, for the full duration of the eight (8) hour test period. If necessary, corrections or repairs shall be made and the full eight-hour test operation, as specified, shall be completed after all parts operate satisfactorily.
2. CONTRACTOR shall furnish and pay for all power, water, fuels, oil, grease, chemicals, and auxiliaries that are required for conducting the CONTRACTOR's testing of the equipment for proper operation, efficiency, and capacity during Pre Start Up.
3. Field Tests of all process and pumping equipment, drive motors, including auxiliaries shall be made in accordance with the appropriate and approved test codes of the American Society of Mechanical Engineers (ASME), Hydraulic Institute Standards, National Electrical Manufacturers Association (NEMA), and Institute of Electrical and Electronics Engineers (IEEE).

4. Field testing shall be conducted before the Work is ready for System Start Up and is substantially complete so each item of equipment is ready for integrated operation with other equipment at the facility. Testing, measuring, and calibrating procedures shall be submitted to the ENGINEER for review and acceptance prior to field testing of equipment. The facility control system must be in place and MANUFACTURER's Certificate of Proper Installation must be completed prior to equipment tests.
5. All equipment shall be tested continuously under actual or simulated operating conditions. Equipment shall be tested over the full range of speed, capacity and pressure. Equipment shall also be tested at every level of control. Valves shall be throttled as required to simulate the full operating range. Curves shall be developed from the test data and compared to the specified performance criteria. CONTRACTOR shall provide all appurtenances as required, but not limited to flow meters for liquid and gas flow pressure gauges and throttling valves, to verify performance. CONTRACTOR shall be fully responsible for the operation and maintenance of the equipment during Pre Start Up. During testing, pressure, flow rate, amperage, voltage, vibration, equipment temperature, ambient temperature, tank level and the level of all water surfaces shall be measured. MANUFACTURER's representative shall make all necessary field adjustments and correct defects in materials or workmanship during this test period. The equipment shall be properly filled, by the CONTRACTOR, with oil and grease.
6. The period of inspection, Pre Start Up operation, and field adjustment shall be as required to achieve satisfactory installation and operation of the items furnished.

C. TEST LOG SUBMITTALS

1. MANUFACTURER's Certificate of Proper Installation – Utilize the MANUFACTURER's Certificate of Proper Installation Form from Section 01640 – Manufacturer's Field Services, supplemented as necessary, to document results, problems, and conclusions.
2. Equipment Test - Test report and certification of test for each piece of equipment, system, subsystem, or component specified. See Section 01640.
3. I/O Loop Test – Third Party Independent Test Agency.
4. Equipment Calibration Sheets - Certifications of calibration for testing equipment and permanent equipment.
5. Electrical Testing - Third Party Independent Test Agency.
6. Certificate of Successful Equipment Testing – Utilize the Certificate of Successful Equipment Testing Form from Section 01640 – Manufacturer's Field Services, supplemented as necessary to document results, problems, and conclusions.

D. ADDITIONAL PRE START UP ACTIVITIES

1. General activities include:

- a. Cleaning.
- b. Removing temporary protective coatings.
- c. Flushing and replacing greases and lubricants, where required by the MANUFACTURER.
- d. Lubrication.
- e. Check shaft and coupling alignments and reset where needed.
- f. Check and set motor, pump and other equipment rotation, safety interlocks, and belt tensions.
- g. Check and correct if necessary leveling plates, grout, bearing plates, anchor bolts, fasteners, and alignment of piping which may put stress on pumping equipment connected to it.
- h. All adjustments required.

2. Minimum activities include:

- a. Bearings and Shafts
 - i. Inspect for cleanliness, clean and remove foreign materials.
 - ii. Verify alignment.
 - iii. Replace defective bearings, and those which run rough or noisy.
 - iv. Grease as necessary, in accordance with MANUFACTURER's recommendations.
- b. Drives
 - i. Adjust tension in V-belt drives, and adjust vary pitch sheaves and drives for proper equipment speed (if necessary).
 - ii. Adjust drives for alignment.
 - iii. Clean and remove foreign materials before starting operation.
- c. Motors
 - i. Check each motor for comparison to amperage nameplate value.
 - ii. Correct conditions which produce excessive current flow, and which exist due to equipment malfunction.
 - iii. Check each motor for proper rotation.
- d. Pumps
 - i. Check glands and seals for cleanliness and adjustment before running pump.
 - ii. Inspect shaft sleeves for scoring.
 - iii. Inspect mechanical faces, chambers, and seal rings, and replace if defective.
 - iv. Verify that piping system is free of dirt and scale before

circulating liquid through the pump.

- e. Valves
 - i. Open and close valves by hand and operate to check for binding, interference, or improper functioning.
 - ii. Inspect both manual and automatic control valves, clean bonnets and stems.
 - iii. Tighten packing glands to assure no leakage, but permit valve stems to operate without galling.
 - iv. Replace packing in valves to retain maximum adjustment after system is judged complete.
 - v. Replace packing on any valve which continues to leak.
 - vi. Remove and repair bonnets which leak.
 - vii. Coat packing gland threads and valve stems with an appropriate surface preparation after cleaning.
- f. Verify that control valve seats are free from foreign material, and are properly positioned for intended service.
- g. Tighten all pipe joints after system has been field tested. Replace gaskets which show any sign of leaking after tightening.
- h. Inspect all joints for leakage.
- i. Promptly remake each joint which appears to be faulty, do not wait for rust to form.
- j. Clean threads on both parts, apply compound and remake joints.
- k. Clean strainers, dirt pockets, orifices, valve seats, and headers in fluid system, to assure freedom from foreign materials.
- l. Open traps and air vents where used, remove operating elements. Clean thoroughly, replace internal parts and put back in readiness mode.
- m. Remove rust, scale and foreign materials from equipment and renew defaced surfaces.
- n. Set and calibrate permanent equipment.
- o. Check each electrical control circuit to assure that operation complies with Contract Documents and requirements to provide desired performance.
- p. Inspect each pressure gage and thermometer for calibration. Replace items which are defaced, broken, or which read incorrectly.
- q. Repair damaged insulation.
- r. Vent gases trapped in any part of systems. Verify that liquids are drained from all parts of gas or air system.
- s. Calibrate testing equipment for accurate results.
- t. Check power supply to electric-powered equipment for correct voltage.

- u. Adjust clearances and torque.
- v. Test piping for leaks.
- w. Balance HVAC systems, measuring airflow (cfm) static pressure, and component pressure losses. Furnish report documenting results of balancing.
- x. Equipment and electrical tagging complete.
- y. All spare parts and special tools delivered to OWNER.

3.03 SYSTEM START UP

A. SUBMITTALS

1. Administrative Submittals.
 - a. Functional and Performance test schedules.
 - b. Plan for equipment, systems, subsystem, or component at least twenty-one (21) calendar days prior to start of related testing. Include test plan, procedures, and log format.
 - c. Schedule and plan of System Start Up activities at least thirty (30) calendar days prior to commencement.
2. Certificate of Successful Equipment, System, Subsystem, or Component Start Up Testing – Utilize the Certificate of Successful Equipment, system, subsystem, or component Start Up Testing Form from Section 01640 – Manufacturer’s Field Services, supplemented as necessary, to document functional and performance procedures, results, problems, and conclusions.

B. CONTRACTOR FACILITY START UP RESPONSIBILITIES

1. General
 - a. Prepare and pretest all equipment insofar as possible to check its ability for sustained operation, including inspections and adjustments by manufacturer’s servicemen.
 - b. Be responsible for System Start Up of all facilities constructed under this Contract.
 - c. Perform Work for tests specified.
 - d. Demonstrate proper installation, adjustment, function and performance of equipment, systems, subsystem, or components, control devices, and required interfaces individually and in conjunction with process instrumentation and control system.
 - e. CONTRACTOR shall furnish and pay for all power, water, fuels, oil, grease, chemicals, and auxiliaries that are required for conducting CONTRACTOR's testing of the equipment for proper operation, efficiency, and the capacity during System Start Up.

C. OWNER'S FACILITY STARTUP RESPONSIBILITIES

1. General

- a. Review CONTRACTOR's test plan and schedule.
- b. Witness each functional and performance tests.
- c. Provide assistance and support for start up and performance testing.
- d. OWNER will operate the portion of facilities that are not part of the construction contract.

D. TESTING PREPARATION

1. General.

- a. Complete Work associated with the equipment, system, subsystem, or components and related processes before testing, including related MANUFACTURER's representative services.
- b. Furnish qualified MANUFACTURER's representatives when required to assist in testing.
- c. Utilize the Certificate of Successful Equipment, System, Subsystem or component Start Up Testing Form from Section 01640 – Manufacturers Field Services, supplemented as necessary, to document functional and performance procedures, results, problems, and conclusions.
- d. Schedule and attend pretest (functional and performance) meetings related to test schedule, plan of test, materials, chemicals, and liquids required, facilities' operations interface, OWNER involvement.
- e. Designate and furnish one or more persons to be responsible for coordinating and expediting CONTRACTOR's System Start Up duties. The person or persons shall be present during System Start Up meetings and shall be available at all times during the System Start Up period.
- f. Provide temporary valves, gauges, piping, test equipment and other materials and equipment required to conduct testing.

2. Cleaning and Checking: Prior to starting functional testing.

- a. Calibrate testing equipment for accurate results.
- b. Inspect and clean equipment, devices, connected piping, and structures so they are free of foreign material.
- c. Lubricate equipment in accordance with MANUFACTURER's instructions.
- d. Turn rotating equipment by hand and check motor-driven equipment for correct rotation.

- e. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
 - f. Check power supply to electric-powered equipment for correct voltage.
 - g. Adjust clearances and torque.
 - h. Test piping for leaks.
 - i. Obtain completion of applicable portions of MANUFACTURER's Certificate of Proper Installation in accordance with Section 01640 – Manufacturer's Field Services.
3. Ready-to-test determination will be by OWNER based at least on the following:
- a. Notification by CONTRACTOR of equipment and system readiness for testing.
 - b. Acceptable Test Log Submittal to OWNER.
 - c. Acceptable testing plan.
 - d. Acceptable Final Draft Operation and Maintenance Manuals.
 - e. Receipt of MANUFACTURER's Certificate of Proper Installation, as required.
 - f. Receipt of Certificate of Successful Equipment Testing, as required.
 - g. Adequate completion of Work adjacent to, or interfacing with, equipment to be tested.
 - h. Availability and acceptability of MANUFACTURER's representative, when specified, to assist in testing of respective equipment, and satisfactory fulfillment of other specified MANUFACTURER's responsibilities.
 - i. Equipment and electrical tagging complete.
 - j. All spare parts and special tools delivered to and become property of the OWNER.

E. FUNCTIONAL TEST - GENERAL

- 1. Begin testing at a time mutually agreed upon by the OWNER and CONTRACTOR.
- 2. OWNER and MANUFACTURER's Representative will be present during test. Notify in writing MANUFACTURER's representative(s) at least twenty-one (21) calendar days prior to scheduled date of functional tests.
- 3. Separate items of equipment demonstrated to function properly during subsystem testing may require no further Functional test if documentation of subsystem testing is acceptable to OWNER.
- 4. Conduct functional tests as specified for each equipment, system, subsystem, on component for a minimum period of eight (8) hours.

5. Demonstrate all operational features and instrumentation and control functions while in automatic mode.
6. If, in OWNER's opinion, functional test results do not meet requirements specified, the systems will be considered as non-conforming.
7. Performance testing shall not commence until the equipment, system, subsystem, or components meets the specified functional tests.

F. PERFORMANCE TEST - GENERAL

1. Begin testing at a time mutually agreed upon by the OWNER and CONTRACTOR.
2. OWNER will be present during test. Notify in writing MANUFACTURER's representative(s) at least twenty-one (21) days prior to scheduled date of performance tests.
3. Conduct performance tests as specified for each equipment, system, subsystem, or component for a minimum period of one (1) day.
4. Unless otherwise indicated, furnish all labor, materials, and supplies for conducting the test and taking all samples and performance measurements.
5. Prepare performance test report summarizing test method. Include test logs, pertinent calculations, and CONTRACTOR's Certificate of Successful Equipment, System, Subsystem, or Component Start Up Testing.

G. SYSTEM START UP TEST PERIOD

1. General.
 - a. Attend planning meetings and arrange for attendance by key major equipment MANUFACTURER representatives as required by the Contract Documents.
 - b. Designate one or more persons on the CONTRACTOR's staff to be able for coordinating and expediting CONTRACTOR's System Start Up duties.
 - c. When System Start Up has commenced, schedule remaining Work so as not to interfere with or delay the completion of System Start Up.
 - d. Support System Start Up activities with adequate staff to prevent delays. Such staff shall include, but not be limited to, equipment, system, subsystem, or component, MANUFACTURER's representatives, electricians, instrumentation and control personnel, millwrights, pipe fitters, and plumbers.
 - e. Furnish and coordinate specified MANUFACTURER's System Start Up services.
2. System Start Up Testing.
 - a. System Start Up of the entire system or any portion thereof requires the

coordinated operation of the facilities by the CONTRACTOR, SUBCONTRACTORS, OWNER's operating personnel, ENGINEER, and MANUFACTURER's representatives.

- b. System Start Up of the entire facility or any portion thereof shall be considered complete when, in the opinion of the OWNER, the facility or designated portion has operated in the manner intended without interruption. This includes any training, functional or performance test periods specified herein.
 - c. An interruption may include but is not limited to any of the following events.
 - i. Failure of CONTRACTOR to maintain qualified onsite System Start Up personnel as schedule D.
 - ii. Failure to meet specified functional or performance tests.
 - iii. Failure of any critical equipment, system, subsystem or component that is not satisfactorily corrected within two (2) hours after failure.
 - iv. Failure of any non-critical equipment, system, subsystem, component that is not satisfactorily corrected within four (4) hours after failure.
 - v. As may be determined by OWNER.
 - d. An interruption will require the System Start Up, then in progress, to be stopped and restarted after corrections are made.
3. Startup Test Reports: As applicable to the equipment furnished, certify in writing that:
- a. Hydraulic structures, piping systems, and valves have been successfully tested.
 - b. Equipment, systems, subsystems, or component have been checked for proper installation, started, and successfully tested to indicate that they are operational.
 - c. Equipment, systems, subsystems, or components are capable of performing their intended functions, including fully automatic.
 - d. Facilities are ready for intended operation.
 - e. Final O&M Manuals have been submitted and approved by OWNER.

3.04 OPERATIONAL TEST

- A. As a condition of Partial Acceptance (Substantial Completion), after all functional and performance tests and the entire system is safe and ready to operate, the OWNER will test all constructed facilities using all specified systems in combination with each other for a period of thirty (30) days continuous operation (either actual or simulated) without interruption due to malfunctions of constructed facilities. All defects of material or

workmanship which appear during this test period shall be corrected by the CONTRACTOR. After such corrections are made, the thirty (30) day test shall be restarted at zero and run again before partial acceptance (substantial completion) of the equipment. The time need not be continuous based on malfunctions of associated existing facilities.

- B. OWNER will supply all power, water, oil, fuels, grease, chemicals, auxiliaries, and operating personnel required for this final operational test.
- C. Each MANUFACTURER who furnishes equipment that requires factory trained service personnel shall adjust the equipment until the operational tests have been met and the results of the operational tests have been accepted by the ENGINEER.
- D. CONTRACTOR's Representative shall be on site for the thirty (30) day operational test for assisting in the operation and maintenance of the System.

END OF SECTION



APPENDIX B

DRAWINGS

7/3/2018 11:36:41 AM - N:\T\18151\PROJECT\SIEMER\09308\200-09308-18001-B\CAD\SHHEE\FILESTREATMENT_FACILITY\E-1001 ELECTRICAL LEGEND & ABBREVIATIONS.DWG - CALZARETTA, TIMOTHY

BACKGROUND PLAN AND ONE LINE SYMBOLS

Table with columns for SYMBOL and DESCRIPTION. Includes symbols for control switches, fuses, breakers, motors, and various electrical components.

CONTROL CIRCUIT & PILOT DEVICE LEGEND

Table with columns for SYMBOL and DESCRIPTION. Includes symbols for switches, relays, coils, and contact types.

WIRING DEVICE SCHEDULE

Table with columns for SYMBOL, DESCRIPTION, and NEMA TYPE. Lists specific wiring devices like clock hangers, switches, and receptacles.

- Vertical list of abbreviations from A to X, such as AMP, ABOVE FINISHED FLOOR, AMPERE INTERRUPTING CAPACITY, etc.

TETRA TECH logo and contact information: www.tetratech.com, 700 N. St. Mary's, Suite 300, San Antonio, TX 78205.

EP-3 BID SET

SAN ANTONIO WATER SYSTEM logo.

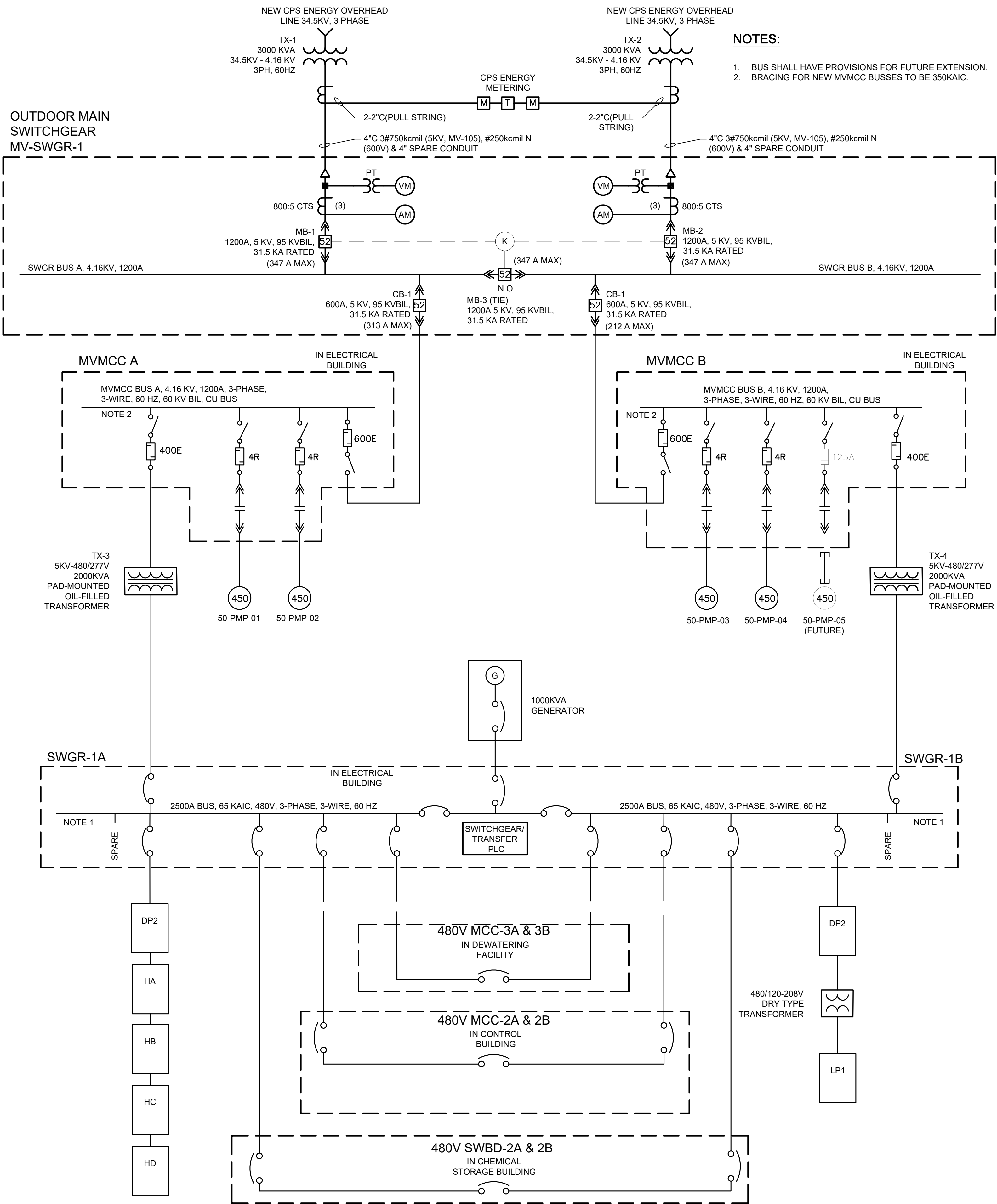
Table with columns for BY, DATE, MARK, DESCRIPTION. A grid for project tracking.

SAN ANTONIO WATER SYSTEM CENTRAL WATER INTEGRATION PIPELINE PROJECT TERMINUS FACILITY ELECTRICAL LEGEND & ABBREVIATIONS

PROJECT INFORMATION: PROJ: 200-09308-18001, DESN: DK, DRWN: DK, CHKD: BRW. Includes a stamp for 'INCOMPLETE DOCUMENT ISSUED FOR INTERIM REVIEW ONLY'.

E-1001

7/3/2018 11:38:41 AM - \\TTS181\FS1\PROJECTS\SIERRA\09308\200-09308-18001-B\CAD\SHEET\FILESTREATMENT_FACILITY\E-1002 STONE OAK PS & TF POWER FUNCT DIAGRAM.DWG - CALZARETTA, TIMOTHY



NOTES:
 1. BUS SHALL HAVE PROVISIONS FOR FUTURE EXTENSION.
 2. BRACING FOR NEW MVMCC BUSSES TO BE 350KAIC.

Description	SAWS Electrical Load Calc			Demand HP	Demand VA	Source	Generator Load
	Connected HP	Connected FLA	Connected VA				
MCC-2A							
VFD Lime Sludge Pump 1 (SB)	10	14	11639			MCC-2A	1
CO2 System Ctl Pnl 1	73	77	64017	73	64017	MCC-2A	1
SSSS CO2 Water Booster Pump No.1 (SB)	75	96	79813			MCC-2A	1
Solution Pump 1	30	40	33255	30	33255	MCC-2A	1
Polymer Mixer 1	1	1.8	1496	1	1496	MCC-2A	1
VFD Backwash Recovery Pump No.1	20	27	22447	20	22447	MCC-2A	1
VFD FTW Recovery Pump No.1	25	34	28267	25	28267	MCC-2A	1
VFD Sludge Transfer Pump No.11	5	7.6	6319	5	6319	MCC-2A	1
VFD Sludge Transfer Pump No.13	3	4.8	3991	3	3991	MCC-2A	1
Sludge Holding Tank Mixer No.1	2	3.4	2827	2	2827	MCC-2A	1
Truck Loading Pump No.15 Panel DP4	7.5	11	9145			MCC-2A	1
			190000		152000	MCC-2A	1
MCC-2B							
VFD Lime Sludge Pump 2	10	14	11639	10	11639	MCC-2B	1
CO2 System Ctl Pnl 2	73	77	64017	73	64017	MCC-2B	1
SSSS CO2 Water Booster Pump No.2	75	96	79813	75	79813	MCC-2B	1
Solution Pump 2	30	40	33255			MCC-2B	1
VFD Backwash Recovery Pump No.2 (SB)	20	27	22447			MCC-2B	1
VFD FTW Recovery Pump No.2 (SB)	25	34	28267			MCC-2B	1
Gravly Thickener Mixer	0.5	1	831	0.5	831	MCC-2B	1
VFD Sludge Transfer Pump No.12	5	7.6	6319	5	6319	MCC-2B	1
VFD Sludge Transfer Pump No.14 (SB)	3	4.8	3991			MCC-2B	1
Truck Loading Pump No.16 Panel DP3	7.5	11	9145			MCC-2B	1
			210000		168000	MCC-2B	1
SWGR-1A							
VFD Pressure Filter Backwash Pump No.1	100	124	103092	100	103092	SWGR-1A	1
VFD Air Scour Blower No.1 (SB) Panel DP1	50	65	54040		40700	SWGR-1A	1
SWGR-1B							
VFD Pressure Filter Backwash Pump No.2 (SB) Panel DP2	100	124	103092			SWGR-1A	1
VFD Air Scour Blower No.2 Panel DP2	50	65	54040	50	54040	SWGR-1A	1
			57300		57300	SWGR-1A	1
MCC-3A							
Cake Storage Bin Screw Conv. No.1 DWT-EF-1	3	4.8	3991	3	3991	MCC-3A	1
DWT-EF-1	0.75	1.4	1164	0.75	1164	MCC-3A	1
Cake Slide Gates (4)	8	11	9145			MCC-3A	1
SSSS Incline Screw Conveyor No.1 (SB) Panel DP5	10	14	11639	10	11639	MCC-3A	1
Centrifuge Ctl Pnl 1	75	96	79813	75	79813	MCC-3A	1
DWT-EF-3	0.75	1.4	1164	0.75	1164	MCC-3A	1
MCC-3B							
SSSS Centrifuge Ctl Pnl 2 (SB)	75	96	79813			MCC-3B	1
Incline Screw Conveyor No.2 (SB)	10	14	11639			MCC-3B	1
Cake Storage Bin Screw Conv. No.2 (SB)	3	4.8	3991			MCC-3B	1
Cake Slide Gates (4) DWT-EF-2	8	11	9145	4	9145	MCC-3B	1
DWT-EF-2	0.75	1.4	1164	0.75	1164	MCC-3A	1
SWBD-2A & 2B							
Panel LP2			21000		16800	SWBD2	1
Hypo Generator No.1			144000		144000	SWBD2	1
Hypo Generator No.2 (SB)			144000			SWBD2	1
OSG-Chiller 1	25	34	28267	25	28267	SWBD2	1
OSG-Chiller 2 (SB)	25	34	28267			SWBD2	1
OSG-RTU-1	25	34	28267	25	28267	SWBD2	1
OSG-RTU-2	25	34	28267	25	28267	SWBD2	1
OSG-DAS-1	15	21	17459	15	17459	SWBD2	1
Hypo Metering Pump No.1	2	3.4	2827	2	2827	SWBD2	1
Hypo Metering Pump No.2	2	3.4	2827	2	2827	SWBD2	1
Hypo Metering Pump No.3	2	3.4	2827	2	2827	SWBD2	1
Hypo Metering Pump No.4 (SB)	2	3.4	2827			SWBD2	1
PC Electrical bldg. Panel Blower Ctl Pnl 1	8	11	9145	4	9145	SWBD2	1

Connected Load	
KVA	A
MCC-2A	453
MCC-2B	470
MCC-3A	172
MCC-3B	105
SWGR-1A & 1B	412
SWBD-2A & 2B	465
SWGR-1 Connected Load	2077

Demand Load	
KVA	A
MCC-2A	315
MCC-2B	331
MCC-3A	150
MCC-3B	9
SWGR-1A & 1B	255
SWBD-2A & 2B	285
SWGR-1 Demand Load	1344

Generator Load	
KVA	A
G-1	1184

5KV LOADS	
KVA	A
50-PMP-01	455
50-PMP-02	455
50-PMP-03	455
50-PMP-04 (Stand-by)	455
SWGR-1	2077
SWGR Connected Load	3897

5KV LOADS	
KVA	A
50-PMP-01	455
50-PMP-02	455
50-PMP-03	455
50-PMP-04 (Stand-by)	0
SWGR-1	1344
SWGR Demand Load	2709

TETRA TECH
 Texas Registration No. F-3924
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SAN ANTONIO WATER SYSTEM

MARK	DATE	DESCRIPTION

SAN ANTONIO WATER SYSTEM
 CENTRAL WATER INTEGRATION PIPELINE
 PROJECT TERMINUS FACILITY
STONE OAK PUMP STATION TF POWER FUNCTION DIAGRAM

PROJ: 200-09308-18001
 DESN: DK
 DRWN: DK
 CHKD: TG

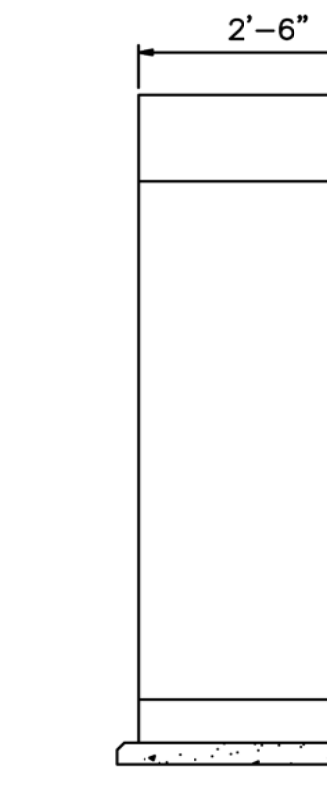
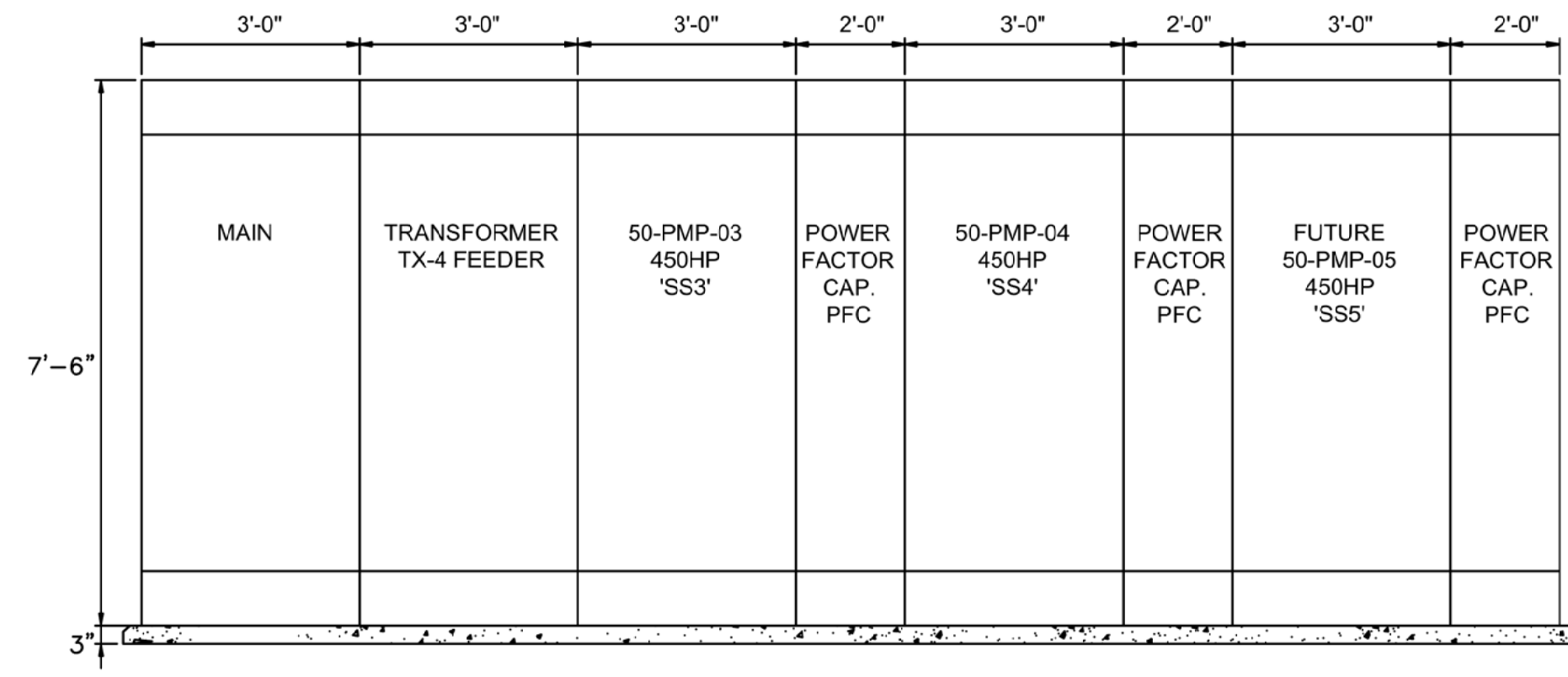
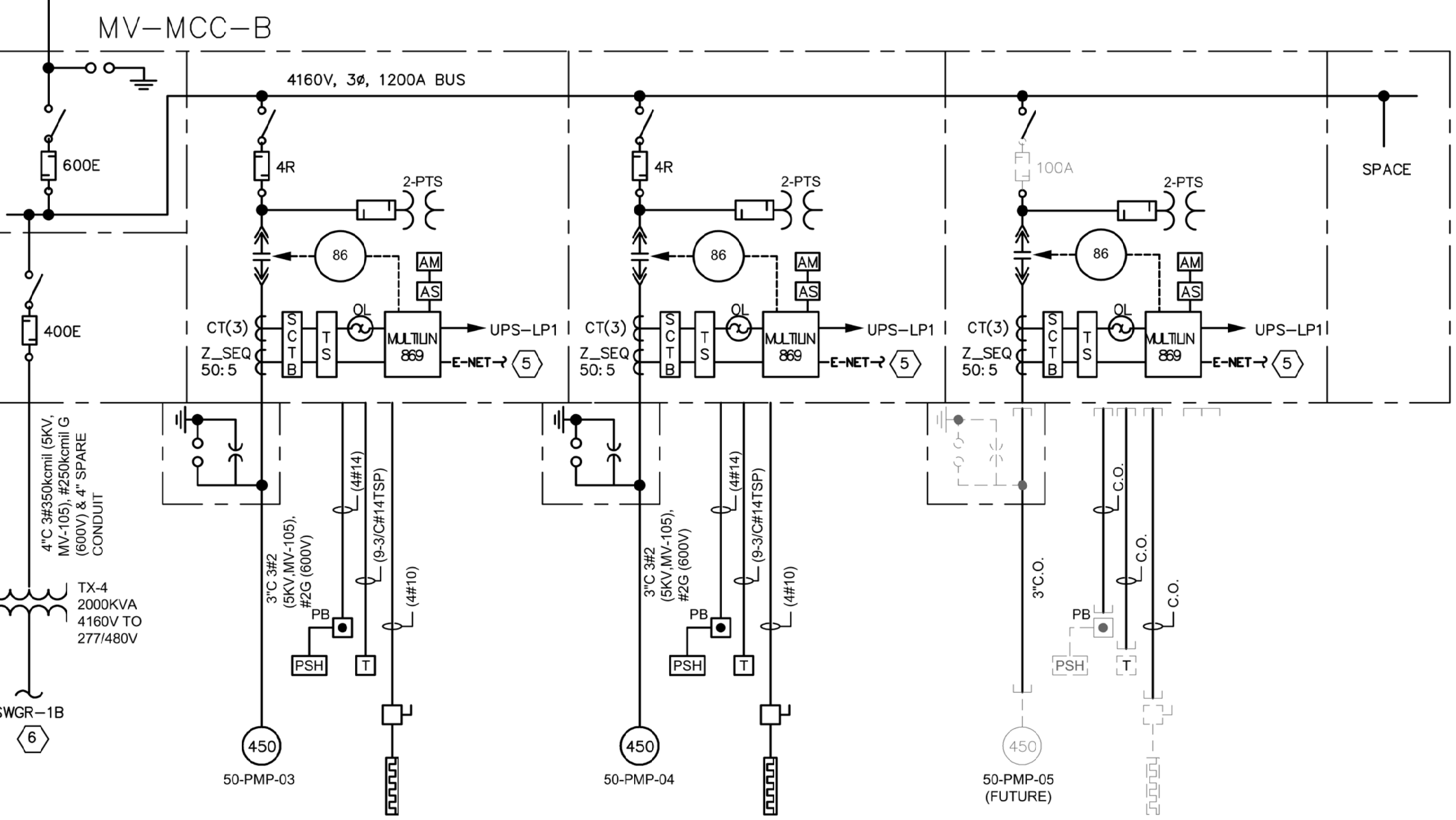
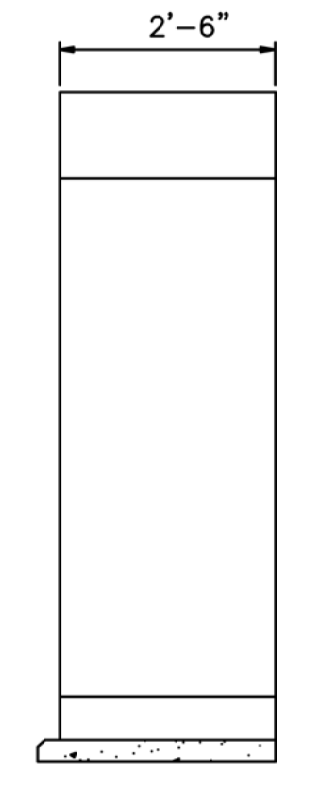
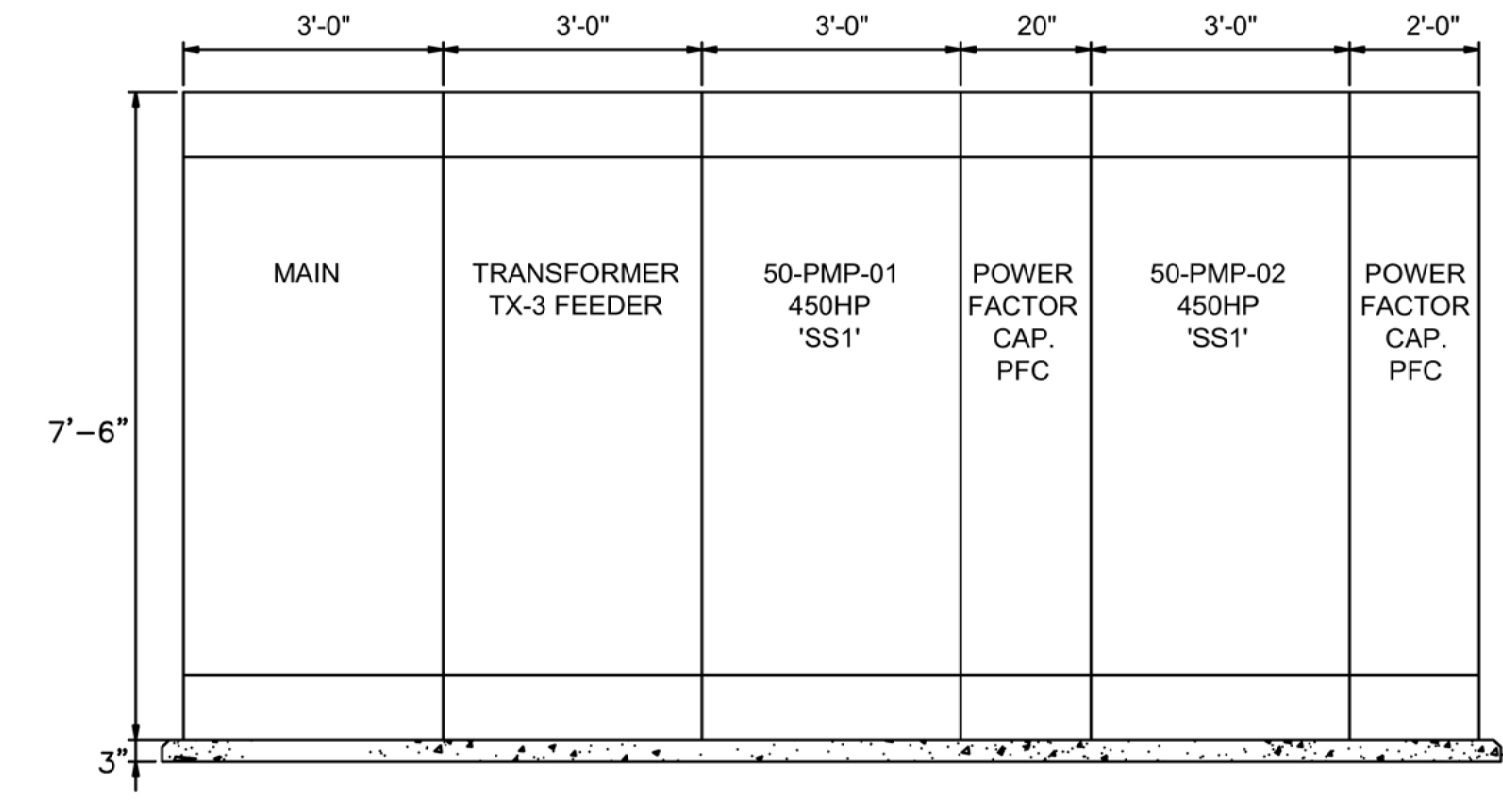
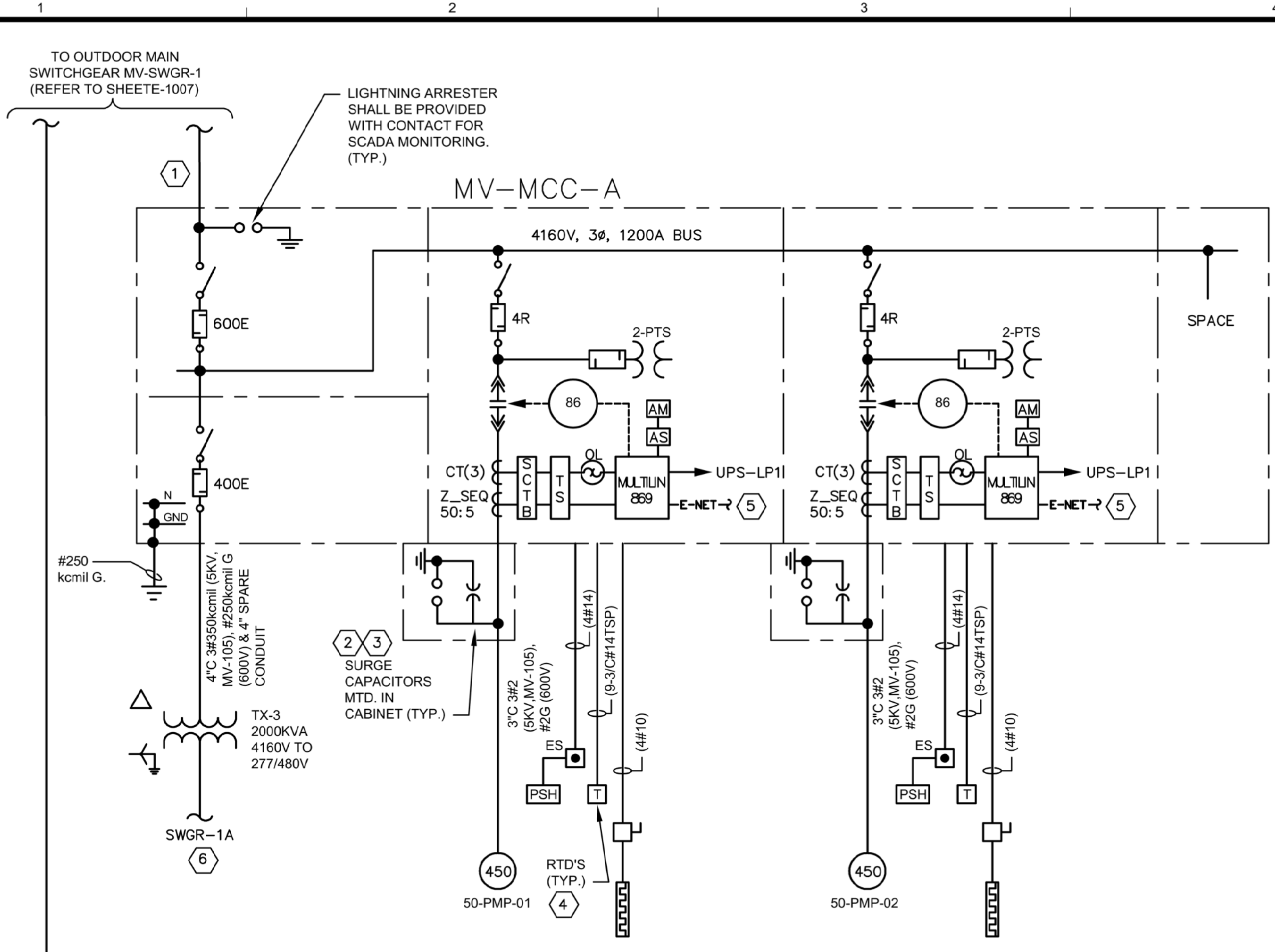
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TIMOTHY D. GOBROGGE
 TEXAS REGISTRATION NO. 128455
 JULY 2018

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7/3/2018 11:42:07 AM - N:\TIS\1815\PROJECTS\SIERRA\09308\200-09308-18001-B\CAD\SHSHEET\FILESTREATMENT_FACILITY\E-1008 MV-MCC-A AND MV-MCC-B ELECTRICAL ONE-LINE DIAGRAM.DWG - CALZARETTA, TIMOTHY



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SAN ANTONIO WATER SYSTEM
CENTRAL WATER INTEGRATION PIPELINE
PROJECT TERMINUS FACILITY
MV-MCC-A AND MV-MCC-B ELECTRICAL ONE-LINE DIAGRAM

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