ADDENDUM NO. 1

Date: **14 October 2011**

San Antonio Water System

Project Name: **Lift Stations Rehabilitation Design - Phase 3**

SAWS Job No. **08-2504**

Solicitation No. **B-11-047-MF**

This addendum, applicable to work referenced above, is an amendment to the bidding documents and as such will be a part of and included in the Contract Documents. Acknowledge receipt of this addendum by entering the addendum number and issue date in the space provided in submitted copies of the proposal.

A. Bidding and Contract Requirement Revisions:

Item 1: **Technical Specifications – Division 16: Electrical**
a) ADD the attached Division 16 Electrical Technical Specifications.

B. Drawing Revisions:

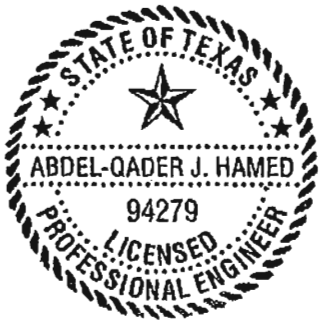
None with Addendum No. 1.

This Addendum, including this **1** page, is **160** pages with attachments and blank pages, in its entirety.

Each bidder is requested to acknowledge receipt of this Addendum No. 1 by his/her signature affixed hereto and to file same with and attached to his/her bid.

10/14/2011

Approved by ENGINEER
WESTON SOLUTIONS, INC.
TEXAS REGISTERED ENGINEERING FIRM F-3123



The undersigned acknowledges receipt of this Addendum No. 1 and the bid submitted herewith is in accordance with the information and stipulations set forth.

_____ _____

Date Signature of Bidder

END OFADDENDUM

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Division 16 – Electrical

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SECTION 16010

ELECTRICAL GENERAL PROVISIONS

PART 1- GENERAL

1.01 WORK INCLUDED:

A. The work includes, but is not limited to, the following principal systems and equipment:

1. 120/208-Volt system.
2. 480-System.
3. Panelboards
4. Mini Power Centers
5. Automatic Transfer Switch
6. Manual Transfer Switch
7. Conduit and Raceways.
8. Transformers.
9. Lighting fixtures and lamps.
10. Grounding
11. Conductors.
12. Miscellaneous controls and Equipment.

1.02 SUMMARY

A. Perform work, furnish and install materials and equipment in full accordance with the latest issue of the applicable rules, regulations, requirements, and specifications of the following:

1. Local laws and ordinances.
2. State and Federal Laws.
3. National Electrical Code (NEC).
4. State Fire Marshal.
5. Underwriters' Laboratories (UL).
6. National Electrical Safety Code (NESC).
7. American National Standards Institute (ANSI).
8. National Electrical Manufacturer's Association (NEMA).
9. National Electrical Contractor's Association (NECA) Standard of Installation.

10. Institute of Electrical and Electronics Engineers (IEEE).
11. Insulated Cable Engineers Association (ICEA).
12. Occupational Safety and Health Act (OSHA).
13. International Electrical Testing Association (NETA).
14. American Society for Testing and Materials (ASTM).
15. National Fire Protection Association (NFPA).
16. American Concrete Institute (ACI).
17. International Building Code (IBC).
18. Insulated Power Cable Engineers Association (IPCEA).
19. Association Edison Illuminating Company (AEIC).
20. Standard for Electrical Safety in the Workplace (NFPA 70E).

B. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory.

C. Product Quality: All electrical items shall be new and unused. Items such as cables, transformers, motors, control centers, etc., shall be newly manufactured for this project. Proof of purchase documents shall be provided upon request. Utilize products of a single manufacturer for each item.

1.03 CONTRACT DOCUMENTS

A. Intent:

1. The intent of the contract drawings or Plans is to establish the types of systems and functions, but not to set forth each item essential to the functioning of the system.
2. Electrical drawings are generally diagrammatic and show approximate location and extent of work.
3. Install the work complete, including minor details necessary to perform the function indicated.
4. In case of doubt as to work intended, or if amplification or clarification is needed, request instructions from the Engineer.
5. It is also the intent of these Contract Documents for the electrical and process system Contractor to coordinate with each other in order to provide a complete and workable system with all wiring, conduit and accessories required which may not be shown on the Plans.
6. The Plans and Specifications are intended to comply with listed codes, ordinances, regulations and standards.

B. Discrepancies:

1. Review pertinent drawings and adjust the work to conditions shown.

2. Where discrepancies occur between Plans, Specifications, and actual field conditions, immediately notify the Engineer in writing and ask for an interpretation.

3. Dimensions on electrical drawings shall be verified with structural, architectural and mechanical drawings.

4. Should installed materials or workmanship fail to comply, the Contractor is responsible for correcting the improper installation.

C. Outlet and Equipment Locations

1. Coordinate the actual locations of electrical outlets and equipment with building features and mechanical equipment as indicated on architectural, structural and mechanical drawings.

2. Review with the Engineer any proposed changes in outlet or equipment location.

3. Relocation of outlets before installation, up to 3 feet from the position indicated, may be directed by Owner without additional cost.

4. Remove and relocate outlets placed in an unsuitable location, when so requested by the Engineer.

1.04 REGULATIONS AND PERMITS

A. Regulations: Work, materials and equipment must comply with the latest rules and regulations of the following:

1. National Electrical Code (NEC).

2. National Electrical Safety Code (NESC).

3. Standard for Electrical Safety in the Workplace (NFPA70E).

4. National Fire Protection Association (NFPA70E).

5. Occupational Safety and Health Act (OSHA).

6. State and federal codes, ordinances and regulations.

7. Local Electrical Code.

B. Permits: Obtain certificates of inspection and other permits required as a part of the work.

1.05 CONTRACTOR QUALIFICATIONS

A. An acceptable Contractor for the work under this division must have personnel with experience, training, and skill to provide a practical working system. The Contractor shall have previous water and wastewater experience with at least 5 years in business.

1. The Contractor shall be required to furnish acceptable evidence of having installed not less than three systems of size and type comparable to this project.

2. The systems must have served satisfactorily for not less than 3 years.

3. The superintendent must have had experience in installing not less than three systems.

4. The Contractor shall submit qualifications of his firm and resumes of his personnel who will work on this project.

5. Contractor shall have performed a minimum of three projects with the San Antonio Water System in the last 5 years

1.06 GENERAL REQUIREMENTS FOR WORKMANSHIP, EQUIPMENT AND MATERIALS

A. All electrical work shall be performed by workmen skilled in the electrical trade and licensed for the work by the local authority.

B. A licensed Master Electrician will be required for the issuance of a building permit for constructing, installing, altering, maintaining, repairing, or replacing any electrical wiring, apparatus, or equipment on any voltage level. A licensed Master Electrician or a licensed Journeyman Electrician holding a current license in the state of Texas is required to be on the job site during the performance of any electrical work. Master Electrician shall spend minimum of 2 hrs per week at the job site reviewing work completed.

C. All cable splicing and termination methods and materials shall be of the type recommended by the splicing materials manufacturer for the cable to be spliced, and shall be approved by the Engineer prior to installation.

D. All materials and equipment shall be installed in accordance with the approved recommendations of the manufacturer, the best practices of the trade, and in conformance with the Contract Documents. The Contractor shall promptly notify the Owner in writing of any conflict between any requirements of the Contract Documents and manufacturer's directions, and shall obtain written instructions from the Owner before proceeding with the work. Should the Contractor perform any work that does not comply with the manufacturer's directions or such written instructions from the Owner, he shall bear all costs arising in correcting deficiencies.

E. All equipment and materials shall be new, unless specifically noted otherwise, and shall bear the manufacturer's name, trademark and ASME, UL, and/or other labels in every case where a standard has been established for the particular item. Equipment shall be the latest approved design of a standard product of a manufacturer regularly engaged in the production of the required type of equipment, and shall be supported by a service organization that is, in the opinion of the Owner, reasonably convenient to the site.

F. The Electrical design is based on preliminary equipment selections. Of contractor provides equipment that is larger than the selections, the contractor is responsible for upsizing all cables, starts, overloads, transformers, etc. to meet the National Electrical Code and provide an overall voltage drop of less than 5%. It is the responsibility of the Contractor to insure that items furnished fit the space available with adequate room for proper operation and maintenance. He shall make measurements to ascertain space requirements, including those for connections, and shall furnish and install such sizes and shapes of equipment that, in the final inspection, will suit the true intent and meaning of the Plans, Specifications and Contract Documents.

G. The Contractor shall furnish and install all equipment, accessories, connections and incidental items necessary to complete the work, ready for use and operation by the Engineer/Owner.

H. When the Engineer/Owner has reviewed equipment submittals and given instructions to proceed with the installation of items of equipment that require arrangements or connections different from those shown on the drawings, it shall be the responsibility of the Contractor to install the equipment to operate properly and in accordance with the intent of the Plans and Specifications, and he shall provide any additional equipment and materials that may be required. The Contractor shall be responsible for the proper location of roughing-in and connections by other trades. All changes shall be made at no increase in the Contract Amount or additional costs to other trades.

I. The Contractor shall support the installation of all equipment, plumb, rigid and true to line. The Contractor shall determine how equipment, fixtures, conduit, etc., are to be installed, and shall provide foundations, bolts, inserts, stands, hangers, brackets and accessories for proper support whether or not shown on the drawings.

1.07 SHOP DRAWINGS AND PRODUCT DATA

A. Data Required:

1. Submit shop drawings, product data and all other required information as specified in Division 1. Submittals are required on all products and items to be installed on this project.

2. Submittal data must show manufacturer's name, published ratings or capacity data, detailed equipment drawing for fabricated items, panel diagrams, wiring diagrams, installation instructions and other pertinent data.

3. Where literature is submitted covering a group or series of similar items, the applicable items must be clearly indicated. Mark through items not being provided and clearly identify all options being provided.

4. Do not combine submittal for multiple Specifications Sections.

B. Submit a letter showing all the exception to the specification. If no exceptions are taken the letter shall indicate no exception. Submittal will be rejected without preliminary review if the letter is not submitted.

C. Submittal Items: Submittals are required for all equipment and materials to be used on this project. Submittals shall be complete with all pertinent information and installation details. Assume all costs and liabilities which may result from the ordering of any material or equipment prior to the review of the shop drawings or submittals, and no work shall be done until the shop drawings or submittals have been reviewed. In case of correction or rejection, resubmit until such time as they are accepted by the Owner's Representative, and such procedures will not be cause for delay.

D. Terminal Connection Diagrams:

1. Submit terminal connection diagrams for approval prior to any wire installation.

2. Submit finalized terminal connection diagrams at the end of the Contract.

3. All manufacturers named are a basis as a standard of quality and substitutions of any equal product will be considered for acceptance. The judgement of equality of product substitution shall be made by the Engineer.

1.08 SYSTEM RESPONSIBILITY

A. The Contractor shall be responsible for:

1. Complete systems in accordance with the intent of these Contract Documents.

2. Coordinating the details of facility equipment and construction for all Specification Divisions which affect the work covered under Division 16, Electrical.

3. Furnishing and installing incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.

4. Coordinate the work with the instrumentation Contractor.

    a. Furnish and install the primary and secondary instruments(i.e level element and level indicating transmitter, etc.).
    b. The conduit and wiring to and from the instruments shall be furnished and installed by the Electrical Contractor. Termination in the instrument shall be by the Instrument Contractor.
    c. All terminations in the control panel shall be by the Instrument Contractor.
    d. The Contractor shall provide termination drawings.
    e. The equipment pad for the control panels, consoles and instrument panels shall be furnished by the Contractor.
    f. The Contractor shall coordinate the testing of the electrical system being furnished. He shall be responsible for the equipment he is supplying.
    g. The Contractor shall be present at time of the instrument system testing and start-up. He shall be responsible to coordinate the testing of the facility with all trades.
    h. The Electrical Contractor shall coordinate the interface requirement between each starter and control panel furnished under this Contract.

B. Electrical plan drawings show only general locations of equipment, devices, and raceway, unless specifically dimensioned. The Contractor shall be responsible for the proper routing of raceway, subject to the approval of the Engineer.

C. Submit to the Engineer in writing details of any necessary, proposed departures from these Contract Documents, and the reasons therefore. Submit such request as soon as practicable, and within ten (10) days after award of the Contract. Make no such departures without written approval of the Engineer.

D. Dimensions on electrical drawings shall be verified with structural, architectural, and mechanical drawings.

E. Where the Contractor is submitting a packaged system, Contractor shall meet the requirements of electrical specifications. This includes field cables, conduits, junction boxes, circuit breakers, combination starters, pushbuttons, pilot lights, and motors. Deviations shall not be accepted, unless approved in writing in advance. Control centers and special control cabinets wired to terminal blocks shall include the manufacturer's standard quality, unless specifically mentioned to the contrary on the drawings or in the specifications.

F. Maintain continuity of electric service to functioning portions of the process or buildings during hours they are normally in use. Temporary outages will be permitted during cutover work at such times and places as can be prearranged with the Owner’s designated Representative. Such outages shall be kept to a minimum number and minimum length of time. Make no outages without prior written authorization of the Engineer. Include costs for temporary wiring and overtime work required in the Contract price. Remove temporary wiring at the completion of the work. The Contractor shall be responsible to provide and pay for temporary power to any facility during construction to facilitate the new construction. If generator is needed contractor shall be responsible for all the cost associated with, including fuel.

G. Unless shown in detail, the drawings are diagrammatic and do not necessarily give exact details as to elevations and routing of raceways, nor do they show all offsets and fittings; nevertheless, install the raceway system to conform to the structural and mechanical conditions of the construction.

H. Cabling inside equipment shall be carefully routed, trained, and laced. Placing cables so that they obstruct equipment devices is not acceptable.

PART 2- PRODUCTS

2.01 PRODUCT REQUIREMENTS

A. Condition: Materials and equipment provided under these Specifications must be new products of manufacturers regularly engaged in production of such equipment. Provide the manufacturer's latest standard design for the type of equipment specified.

B. NEC and UL: Products must conform to requirements of the National Electrical Code. Where Underwriters' Laboratories have set standards, listed products, and issued labels, products used must be listed and labeled by UL.

C. NEMA and IEC: Only NEMA rated equipment is acceptable. IEC or dual rated NEMA/IEC equipment are not acceptable.

D. Space Limitations: Equipment selected must conform to the buildings features and must be coordinated with them. Do not provide equipment that will not suit arrangement and space limitations.

E. Factory Finish: Equipment must be delivered with a hard surface, factory-applied finish so that no additional field painting is required.

F. Field Installation: All field installed equipment, conduit, etc., shall require Type 316 stainless steel nuts, bolts, washers, metal framing and supports, and other items as indicated on the Plans.

G. Installation and supply of electrical equipment shall be conformed to NEC 500, for classified area.

H. Sesmic Design: All electrical equipment to be designed in accordance with/IBC-2006 & ASCE 7-05 code for Sesmic Design.

PART 3- EXECUTION

3.01 PROTECTION OF EQUIPMENT

A. Moisture:

1. During construction, provide heaters to protect switchgear, transformers, motors, control equipment, and other items from moisture absorption and corrosion.

2. Apply protection immediately on receiving the products and provide continuous protection.

3. Store all equipment indoors in dry, well ventilated and heated space.

B. Clean: Keep products clean by elevating above ground or floor and by using suitable coverings.

C. Damage: Take such precautions as are necessary to protect apparatus and materials from damage. Failure to protect materials is sufficient cause for rejection of the apparatus or material in question.

D. Finish: Protect factory finish from damage during construction operations and until final acceptance of the project.

E. Protect Equipment per the manufacturer's requirements.

3.02 INSTALLATION

A. Labeling

1. All electrical equipment must be properly labeled and have warning signs per most current edition of the NEC.

B. Cooperation with Other Trades:

1. Cooperation with trades of adjacent, related or affected materials or operations, and of trades performing continuations of this work under subsequent contracts, is considered a part of this work in order to effect timely and accurate placing of work and to bring together, in proper and correct sequence, the work of such trades.

2. Coordinated equipment layout in sufficient time to be coordinated with work of others, provide drawings and layout work showing exact size and location of sleeves, openings or inserts for electrical equipment in slabs, walls, partitions and chases.

C. Workmanship: Work must be performed by workmen skilled in their trade. The installation must be complete whether the work is concealed or exposed.

D. Setting of Equipment:

1. Equipment must be leveled and set plumb.

2. Stainless Steel 316 enclosures mounted against a wall must be separated from the wall not less than 1/2-inch by means of corrosion resistant spacers or by 3 inches of air for freestanding units.

3. Stainless Steel 316 bolts, nuts and washers to anchor the equipment.

E. Sealing of Equipment:

1. Permanently seal outdoor equipment at the base using concrete grout.

2. Seal or screen openings into equipment to prevent entrance of animals, birds and insects.

3. Use stainless steel mesh with openings not larger than 1/16-inch squares for screened openings.

4. Seal small cracks and openings from the inside with silicone sealing compound.

F. Concealed Work: Conceal electrical work in walls, floors, chases, under floors, underground and above ceilings except:

1. Where shown or specified to be exposed. Exposed is understood to mean open to view.

2. Where exposure is necessary to the proper function.

3. Where size of materials and equipment precludes concealment.

3.03 TESTING

A. Test Conditions:

1. Place circuits and equipment into service under normal conditions, collectively and separately, as may be necessary to determine satisfactory operation.

2. Perform specified tests in the presence of the Engineer, as specified in Division 1- General Requirements and 16- Electrical.

3. Furnish all instruments, wiring, equipment, and personnel required for conducting tests.

4. Demonstrate that the equipment operates in accordance with requirements of the plans and specifications.

5. No process equipment is to be operated until any associated HVAC equipment and auxiliary equipment is operational.

B. Test Dates: Schedule final acceptance tests sufficiently in advance of the Contract completion date to permit completion of any necessary adjustment or alterations within the number of days allotted for completion of the Contract.

C. Retests: Conduct retests as directed by the Engineer of such time duration as may be necessary to assure proper functioning of adjusted or altered parts or items of equipment. Any resultant delay as a result of such necessary retests does not relieve the Contractor of his responsibility under this contract. Provide notice to Engineer and Owner of testing 30-days prior to testing.

3.04 PROJECT RECORD DOCUMENTS

A. Preparation:

1. At the job site, maintain a set of white prints of the contract drawings.

2. At the job site, maintain a set of equipment terminal connection diagrams.

3. On the prints, record field changes and diagrams of those portions of work in which actual construction is at variance with the contract drawings.

4. Mark the drawings with a colored pencil. Record installed feeder conduits, dimensioning the exact location and elevation of the conduit.

B. Delivery: Deliver record drawings to the Engineer in the number and manner specified in Division 1 - General Requirements.

3.05 CUTTING AND PATCHING

A. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of the Engineer. Carefully carry out any cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Do not cut beams for any reason. Following such work, restore surfaces neatly to original condition.

3.06 LOAD BALANCE

A. The Drawings and Specifications indicate circuiting to electrical loads and distribution equipment. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, etc.

3.07 CLEANING AND TOUCH-UP PAINTING

A. Touch up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, consistency, and type of surface of the original finish. If extensive damage is done to equipment paint surfaces, refinish the entire equipment in a manner that provides finish equal to or better than the factory finish, and that meets the requirements of the Specifications and is acceptable to the Engineer.

B. Remove all temporary labels, dirt, paint, grease and stains from all exposed equipment. Upon completion of work, clean equipment and the entire installation so as to present a first class job suitable for occupancy. No loose parts or scraps of equipment shall be left on the premises.

C. All temporary wiring, wiring devices and associated equipment shall be removed upon completion of the project.

END OF SECTION 16010

SECTION 16012

IDENTIFICATIONS

PART 1- GENERAL

1.01 WORK INCLUDED

A. Furnish and install tags/nameplate on all equipment, devices, instruments, conduit and conductor marking as indicated on the drawings and specified herein. Major equipment shall be furnished with nameplates in accordance with their individual specifications.

1.02 SUBMITTALS

A. Submit to the Engineer, in accordance with Division 1, detailed catalog information or drawings describing electrical and physical characteristics of all equipment specified.

B. Submittal shall be clearly marked showing only equipment provided. Mark through equipment option not provided.

C. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.

D. Submit a letter showing all the exception to the specification. If no exceptions are taken the letter shall indicate no exception. Submittal will be rejected without preliminary review if the letter is not submitted.

PART 2- PRODUCTS

2.01 WIRE MARKERS

A. Provide heat shrinkable sleeves and machine printed legends at every conductor. Sleeves and legends shall be high resistant to abrasion, solvents and chemicals. Provide Tyco TMS, or Brady Perma Sleeve XPS. Markers shall be white with black lettering.

B. Markers shall have conductor origin, termination and circuit number, terminal number whichever applies.

C. Large conductors, multi-conductor cable and tray cables to be identified with placards held on with wire ties and of the same quality as markers for smaller single conductors.

D. Cables in cable tray to be identified with place cards at the equipment and at 20 feet spans in between.

E. All control wiring in electrical equipment or manufactured supplied panel shall have wire markers.

2.02 CONDUIT MARKERS

A. Exposed Conduit

1. Conduit markers to be stainless steel type permitting embossing on the job and attached to conduit with banding made of same material. Markers to be installed lengthwise and wrapped with clear adhesive tape.

2. Conduits to be marked at the point of origin, the point of termination, upon crossing wall, each side of junction boxes and at 20-foot internals for all exposed and accessible conduits. Identify all exposed conduits by their panel, MCC, circuit numbers or loop numbers.

3. Stencil high voltage conduit with the legend "HIGH VOLTAGE" and indicate voltage stenciled in minimum 1-inch high red letters.

2.03 NAMEPLATES

A. Nameplates:

1. Externally mark electrical equipment by means of suitable nameplates identifying each and the equipment served.

2. Provide each piece of equipment with a white phenolic nameplate with 3/16-inch-high black lettering secured to front of equipment.

3. Supply blank nameplates for spare units and used spaces.

4. Actual nameplate legend, which may consist of up to three lines, will be provided to the Engineer on submittals.

B. Nameplate Fasteners: Fasten nameplates to equipment only by means of appropriate 316 SS screws and gasket. Stick-ons or adhesives will not be allowed.

C. Nameplate Information: In general, the following information is to be provided for the types of electrical equipment as listed.

1. Switchgear, Motor Control Centers and Distribution Panelboards: On the mains, identify the piece of equipment, the source, and voltage characteristics, i.e., 480V, 3PH, 3W, etc. For each branch circuit protective device, identify the load served and the primary side circuit number.

2. Transformers: Identify the service source and load served.

3. Panelboards: Identify the service source, panelboard designation and voltage characteristics.

D. Panelboards:

1. Prepare a neatly typed circuit directory behind clear heat-resistant plastic for each panelboard.

2. Identify circuits by equipment served and by room numbers, where room numbers exist.

3. Use equipment names and room numbers selected by the Engineer; names and numbers may be different from those shown on plans.

4. Indicate spares and spaces with light, erasable pencil markings.

5. Provide a final set of the panel schedule in the O&M manuals.

6. Provide a CD with the file for each Panel to the Owner with the O&M manual.

E. Boxes, Small Equipment:

1. Pull boxes and similar items shall be marked with Nameplates.

2. Provide identification stencils for high voltage equipment and raceways with the legend "DANGER HIGH VOLTAGE". Mark all exposed high voltage raceways every 25 feet.

F. Power Receptacles: Use nameplate or engraved plate to identify power receptacles where the nominal voltage between a pair of contacts is greater than 150 volts with circuit number, voltage, and phases.

G. Wall Switches: Engrave the switch plate of the switch with the function of the switch.

2.04 POWER OUTLETS, SWITCHES, AND PILOT DEVICES

A. Mark power outlets with voltage, phase, panel name, and circuit number.

B. Identify all wall switches, disconnect switches, etc. with nametags, circuits served, and panel origin, list to be approved by Engineer/Owner.

C. Identify all push-button stations with their functions and equipment served.

2.05 DETECTABLE WARNING TAPE

A. Shall be red metal detectable polyester with a subsurface graphics to esal the legend from acid, alkalis and other soil substances.

B. Minimum width shall be 2".

C. Warning tape shall meet OSHA regulation for covering location of underground utility lines.

D. The legend shall show CAUTION: BURIED ELECTRIC LINE BELOW

E. The warning tape shall be Red with black lettering.

F. Acceptable manufacturer shall be Brady 91601 or Engineer approved equal.

PART 3- EXECUTION

3.01 FURNISH AND INSTALL NAMEPLATES/TAGS

A. Furnish and install nameplates for all panelboards, motor starters, motor control center cubicles, disconnect switches, instrument panels, dry type transformers and control stations.

B. Engrave the equipment designation, (e.g., "Starter Pump P1"), on nameplates in 3/16-inch black letters on white background of laminated phenolic. Securely fasten nameplates using stainless steel 316 sheet metal screws or rivets; or contact cement if enclosure is sealed. All switches, indicating lights, pushbuttons, meters and parameter indicators on panels shall be clearly identified with its function or tag, as required. Identification list to be approved by plant personnel through the Engineer.

C. Stainless Steel tags shall be used on instrument, motors and other devices, as applicable. The tags shall be affixed to the instrument with drive pins or stainless steel chain in such a manner that it does not need to be removed to install the instrument. Motors shall carry the tag assigned to its driven equipment, (e.g., P-101).

END OF SECTION 16012

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SECTION 16020

UTILITIES

PART 1- GENERAL

1.01 WORK INCLUDED

A. Furnish and install necessary materials and make arrangements for the connection of utilities for the project. The required utilities are electrical services upgrades to lift station.

1.02 REFERENCE STANDARDS

A. Comply with all service installation standards of the serving utility companies.

PART 2- PRODUCTS

2.01 ELECTRICAL SERVICE

A. The Contractor shall coordinate with Power Company installation of work as shown on the drawings. Utility contact information:

1. Chris Lansford: Tel: (210) 353-2810 or Email: CALansford@cpsenergy.com

B. Entrance must be coordinated with the Engineer/Owner. Provide materials and equipment required to connect the project service to the system. Coordinate with CPS Energy for requirements of power service. All connection costs to be paid by the Owner.

PART 3- EXECUTION

3.01 UTILITY

A. Electric company is to replace two existing transformers one 25kV Delta/480V/277y transformer and one 12.5kV Delta 480V/277y transformer to serve the new load.

B. Contractor will keep existing services until the new services to the electrical equipment are connected, tested and accepted.

C. Contractor to follow the mechanical construction sequencing Section 01110, electrical equipment shall be energized on time. Delay to the startup shall not be caused due to electrical contractor miscoordination.

D. Contractor to minimize interruption of service. Contractor to coordinate with Owner prior any interruption per Section 01110.

E. All fees required by the electric utility company will be paid directly to the electric utility company by the Owner.

F. Contractor is to provide and install all low voltage (120V, 208V, 480V, etc.) distribution equipment and hardware associated with this project as shown on the plan drawings

END OF SECTION 16020

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SECTION 16040

ELECTRICAL MOTOR 150HP AND LESS

PART 1- GENERAL

1.01 WORK INCLUDED

A. Equipment: This section specifies general requirements for fractional and integral horsepower electric motors 150hp and below with a voltage rating of 480VAC or below. Unless otherwise specified, provide motors meeting the basic requirements for high efficiency premium insulation general-purpose alternating current motors, as defined in NEMA MG 1.

B. Unit Responsibility: Motors shall be furnished under other sections of this specification as a part of the driven equipment. The contractor is responsible for all coordination between the various components, as well as for the warranty.

C. Exceptions: Exceptions to this section are listed in the various sections that specify motor-driven equipment or are indicated on the drawings.

D. Motors connected to variable frequency drives shall be inverter duty rated; each bearing on the non-drive end shall be insulated.

E. This specification does not cover Submersible Motors.

1.02 REFERENCE STANDARDS

A. The following standards shall apply as if written here in their entirety:

1. ANSI/NEMA MG1 - Motors and Generators.

2. ANSI/UL 674(A) - Safety Standard for Electric Motors and Generators for Use in Hazardous Locations, Class II, Groups E, F and G.

3. ANSI/UL 674(B) - Safety Standard for Electric Motors and Generators for Use in Hazardous Locations, Class I, Groups C and D.

4. NFPA 70 - National Electrical Code (latest Edition).

5. IEEE 112 - Standard Test Procedure for polyphase induction motors and generators.

6. UL 1004 - Electric Motors.

1.03 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components that fails in materials or workmanship within specified warranty period.

B. Warranty Period: Motor(s) furnished herein shall include a two (2) year manufacturer’s warranty from date of acceptance.

1.04 SUBMITTALS

A. Requirements: Refer to, Division 1 and Division 16 and to the specific driven equipment sections.

B. Information: Include the following information on the attached motor data sheet.

1. Manufacturer.
2. Rated full load horsepower.
3. Rated volts.
4. Number of phases.
5. Frequency in hertz.
6. Locked rotor amperes (LRA) at rated voltage or NEMA code letter.
7. NEMA design letter.
8. Bearing Type.
9. Service Factor.
10. Nominal speed at full load.
11. Full Load Amperes (FLA)
12. Efficiency at 1/2, 3/4 and full load.
13. Power factor at no load, 1/2, 3/4 and full load.
14. NEMA insulation system classification. For motors installed outdoors, include information showing compliance with the intent of paragraph 2.3D.
15. Corrosion duty rating
16. Fan, end bell cast evidence.

C. Integral Horsepower Motors 40HP and Larger: In addition to the information listed above, include:

1. No load amperes.
2. Safe stall time.
3. Maximum guaranteed slip at full load.
4. Motor damage curves for motors larger than 100HP.
5. Motor manufacturer recommended maximum power factor correction capacitor KVAR.

D. Include the motor data sheet at the end of this section in submittal.

E. The motor manufacturer shall provide in writing that he has coordinated the motor data with VFD and or RVSS manufacturer and that the motor is suitable for VFD or RVSS application.

F. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.

G. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

PART 2- PRODUCTS

2.01 RATING

A. Speed and Size:

1. Speed and horsepower sizes are specified in the driven equipment specification sections or are indicated on the drawings.

2. Furnish motors sufficiently sized for the particular application and with full-load rating not less than required by the driven equipment at specified capacity.

3. Size motors so as not to overload at any point throughout the normal operating range.

4. Furnish dual speed motors of two speed, two winding type, when specified.

B. Frequency: 60 hertz.

C. Service Factor: 1.15 for all motors.

2.02 DESIGN TYPE

A. Motors 1/6 Through 1/2 Horsepower: Provide single-phase 120 volts, NEMA Design N, induction motors.

B. Motors Smaller Than 1/6 Horsepower: Provide single-phase 120 volts, induction motors with integral thermal protectors.

C. Motors Larger Than 1/2 Horsepower: Provide 3-phase, 480 volts NEMA Design B, induction motors unless specified otherwise.

D. Acceleration NEMA Time: If the calculated acceleration time of the combined motor and driven load exceeds 3 seconds at 90 percent of rated voltage, request review by the Engineer. Do not proceed with manufacturing without approval.

E. All induction motors shall have squirrel cage rotors.

F. Motor shall be suitable for outdoor environment.

2.03 MOTOR INSULATION AND WINDING

A. Class: Use a Class F insulation with temperature Rise of Class B or better, meeting the requirements of NEMA MG 1 and made of non-hygroscopic materials. The insulation shall be manufacturer's premium grade, resistant to attack by moisture, acids, alkalies, and mechanical or thermal shock for 480-volt motors.

B. All insulated winding conductors shall be copper.

C. Insulation for inverter duty motor shall meet or exceed the Pulse Endurance Index for magnetic wire and shall not be damaged when exposed to repeated pulse type wave forms, repetitive high voltage

transients, switching frequency and rate of rise of the pulse. All bearings on the non-drive end shall be insulated.

D. Outdoor Suitability, all motors must be suitable for outdoor installation.

2.04 GROUNDING CONNECTIONS

A. Ground provisions shall be furnished per NEMA STANDARD.

B. For motors less than 1/6 HP, each motor shall be furnished with provision for attaching a ground connection to the motor frame inside the motor terminal housing.

2.05 LEADS

A. For motor leads, use not less than ASTM B 173, Class G, stranded copper conductors with insulation the same as or better than specified in the preceding Motor Insulation paragraph.

B. Provide permanent identification numbers on leads according to NEMA MG.

C. Use crimp-on, solderless tinned copper terminals on leads and place heat-shrink insulation sleeves or covers between leads and terminals.

2.06 ENCLOSURE

A. Use enclosure type as follows:

1. Indoors: Totally enclosed, fan cooled (TEFC).

2. Outdoors: Totally enclosed, fan cooled (TEFC), weatherproof.

3. Class 1 Division 2 Area: Provide motors totally enclosed, non vented, explosion proof (TEFC-XP).

4. Class 1 Division 1 Area: Provide motors rated for this class.

5. Motors mounted vertically shall be provided with the rain/snow shield made of the same material as the motor frame.

6. Motors shall have drain openings and plugs suitably located for the type assembly being provided.

7. Motor shall be corrosion resistant and severe duty rated per IEEE 841.

B. TEFC motors shall have a cast iron frame, cast iron end brackets, cast iron bell frame, cast iron conduit box, tapped drain holes (erosion resistant plug for frames 286T(20HP) and smaller and automatic breaker/drain devices for frame 324T(25HP) and larger, and upgraded insulation by additional dips and baked to increase moisture resistance.

2.07 BEARINGS

A. Motors smaller than 1/6 Horsepower: Motor manufacturer's standard bearing is acceptable.

B. Motors 1/6 Horsepower and Larger: Supply these motors with grease-lubricated antifriction ball bearings conservatively rated for 60,000 hours L10 minimum life of continuous operation under the total radial and thrust loads produced by the actual combination of motor-driven equipment. Provide each motor with suitable lubrication fittings and pressure relief devices.

C. Oil Lubricated: If the driven equipment section specifies oil-lubricated bearings for motors, include a suitable sight gauge on each bearing with maximum and minimum levels clearly indicated.

D. Unless specified otherwise in the driven equipment specifications. Motor bearing life shall be 60,000 hours L10 minimum life whichever is greater.

2.08 NAMEPLATES

A. Main Nameplate: Provide each motor with a stainless steel nameplate meeting the requirements of NEMA MG, and the National Electrical Code, Section 430-7.

B. Heater Nameplate: When space heaters are furnished, include voltage and wattage on a suitable nameplate.

C. Bearings Nameplate: When bearings are oil lubricated, include oil type information on a suitable nameplate. Also, indicate bearing data if nonstandard.

D. Attachment: Attach the nameplates to the motor with stainless steel fastening pins or screws.

2.09 IDENTIFICATIONS:

A. All motors shall be identified per Section 16012.

2.10 CONDUIT BOX

A. Provide each motor not supplied with a cord and plug with a conduit box amply dimensioned for the motor lead terminations. Include a grounding lug on motors 1/6 horsepower and larger. Supply a gasket suitable for the motor enclosure type and application.

B. Provide an oversize box to facilitate wiring terminations.

C. Oversized terminal box shall have a volume greater than or equal to the next standard NEMA size box.

D. Terminals shall be tinned copper.

2.11 SPACE HEATERS

A. Provide space heaters in all motors 25HP and above.

1. Use heaters hermetically sealed in stainless steel or equivalent corrosion-resistant sheaths.

2. Heaters shall be rated for 240V, but will be operated at 120 volts.

3. Braze heat-resistant insulated leads to the heater or supply heater with brazed leads and extend to the conduit box.

2.12 MONITORING DEVICES

A. Motor shall be protected and be supply with necessary monitoring devices per driven equipment specification and contract drawing.

2.13 PAINT

A. Shall be severe duty and shall have an epoxy coating per IEEE 841.

2.14 ACCEPTABLE MANUFACTURERS

A. The motor model shall be as listed and manufactured by one or more of the following manufacturers unless otherwise approved by the Engineer.

1. General Electric.
2. TECO/Westinghouse
3. Siemens.
4. Toshiba.
5. US Motors.

2.15 MOTOR EFFICIENCIES

A. Three phase motors rated 1 Hp and larger shall be of the NEMA premium efficiency type. Efficiency values shall be based on tests performed in accordance with IEEE Publication No. 112, Method B. Motors with horsepower or rpm's not listed shall conform to comparable standards of construction and materials as those for listed motors.

B. Motor shall be severe duty rated for industrial application.

PART 3- EXECUTION

3.01 INSTALLATION

A. The Contractor shall make all electrical connections to equipment specified. Installation shall be made in compliance with manufacturer's recommendations and the Contract Drawings. If the Contract Drawings or drawings and recommendations from the Manufacturer are not available then installation shall proceed according to the best electrical industry and trade practice.

B. Properly install and align motors in the locations shown, except motors which are factory mounted on the driven equipment. When the motor and equipment are installed, the nameplate must be in full view.

3.02 LARGER MOTORS

A. If a motor horsepower rating larger than indicated is offered as a substitute and accepted, provide required changes in conductors, motor controllers, overload relays, fuses, breakers, switches and other related items with no change in the contract price.

3.03 TESTING

A. General: Provide all necessary instruments, labor and personnel required to perform motor inspection and testing.

B. Inspection: Inspect all motors for damage, moisture, alignment, freedom of rotation, proper lubrication, oil leaks, phase identification and cleanliness, and report any abnormalities to Engineer before energizing.

C. Energizing: After installation has been thoroughly checked and found to be in proper condition, with thermal overloads in motor controllers properly rated and all controls in place, energize the equipment at system voltage for operational testing.

D. As a part of the testing procedure, the Contractor shall prepare a card for each motor, 20 HP and larger, installed on this contract. After each motor has been run to operating temperature, the motor shall be shut down and an insulation resistance shall be made, using a megohmmeter. Make the test immediately after shutdown. Record megohmmeter reading and winding temperature. Correct reading of insulation resistance to 40° C/104°F. Insulation resistance in megohms, corrected to 40° C, shall be at least equal to one (1) megohm for each 1000 volts applied.

E. Testing shall be in accordance with Division 16.

ELECTRIC MOTOR QUESTIONNAIRE
Motor Data

Manufacturer: _____ Motor HP: _____
Frame _____ Enclosure: _____
Type: _____ RPM: _____
Voltage: _____ Phases: _____ Hertz: _____
Starting Method: _____
Shaft: Size: _____
Insulation Class: _____ Duty: _____

Full Load AMPS: _____ No Load AMPS: _____
Locked Rotor AMPS: _____ Locked Rotor Time: _____
Locked Rotor Torque: _____ % Breakdown Torque: _____
Locked Rotor KVA/HP: _____ Rotor WK2 (lb-ft2): _____

NEMA Design: _____ Service Factor: _____Inrush Current (% of Full Load): _____

Max Safe Stalled Time (Seconds):_____

Number of Safe Starts Per Day:_____ Number of Consecutive Starts:_____

*Full Load Temp Rise, degrees C over 40° C Ambient (at 1.0 S.F.): _____

*Service Factor Temp Rise, degrees C over 40° C Ambient (at 1.15 S.F.): _____

*Limiting Temperature Rise: _____

Resistance (at 25□ C):_____

Bearings: Type/Size _____ Life _____ Lubrication:_____

Exhaust Air (CFM): _____ Exhaust Air Temp Rise (°F): _____

	EFFICIENCY:	POWER FACTOR:	CURRENT
1.15 S.F. Load:			
4/4 Load:			
3/4 Load:			
1/2 Load:			
1/4 Load:			

*Temperature rise measured by embedded detectors and not by resistance.

All Data Fields To Be Completed By The Motor Manufacturer

END OF SECTION 16040

SECTION 16055

POWER SYSTEM STUDIES

PART 1- GENERAL

1.01 WORK INCLUDED

A. Short Circuit Studies, Protective Device Evaluation Studies, Arc Flash Studies and Protective Device Coordination Studies, shall be performed by an electrical testing service firm regularly engaged in power system studies. The company and individual(s) performing the study shall have a minimum 5 years documented experience in power system analysis and completed projects of similar size and scope. The individual(s) performing the study shall be a registered Professional Engineer in the State of Texas.

B. The studies shall be submitted to the Engineer prior to receiving final approval of the distribution equipment shop drawings, and/or prior to release of equipment for manufacture. If formal completion of the studies cause delay in equipment manufacture, approval from the Engineer may be obtained for a preliminary submittal of sufficient study data to ensure that the selection of device ratings and characteristics will be satisfactory.

C. The studies shall include all portions of the electrical distribution system from the normal power source or sources down to, and including, the 120/208-Volt distribution system, including 208V main 3 phase circuit breaker and all 208V, 3 phase loads. Study shall also include all manufacturer supplied equipment. Normal system connections and those, which result in maximum fault conditions, shall be adequately covered in the study. System showing the largest load or partial list of the equipment on the bus will be rejected.

D. Protective relay devices with microprocessor based settings shall be determined with the study.

E. The work associated with this section is to be performed by or under the direction of a professional engineer licensed by the State of Texas.

1.02 SUBMITTAL

A. The results of the power system study shall be summarized in a final report. Six (6) bound copies of the final report shall be submitted. Report to be sealed by a professional engineer licensed in the State of Texas. Submit a preliminary report for approval prior to release equipment for manufacture.

B. The report shall include the following sections:

1. Description, purpose, basis, and scope of the study and a single-line diagram of that portion of the power system which are included within the scope of the study.

2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short circuit duties and commentary regarding same.

3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.

4. Fault current calculations, including a definition of terms and guide for interpretation of computer printout.

5. A letter from utility provider showing available short circuit current at the service entrance.

6. A complete list of all recommended settings for all protective relays, including all solid state protective relay packages.

7. A complete detail of the Arc Flash Study analysis as specified in 2.04.

8. An arc flash label showing the information requested in section 2.

9. An electronic version of the analysis, to be submitted for the final report.

10. The electronic version shall include the backup folder with all the libraries files.

C. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

PART 2- PRODUCTS

2.01 DATA COLLECTION FOR THE STUDIES

A. The Contractor shall provide the required data including field settings on existing equipment for preparation of the studies. The switchboard/switchgear and MCC manufacturer shall furnish the Contractor with a listing of the required data immediately after award of the Contract.

B. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings, and/or prior to release of the equipment for manufacturer.

C. The Contractor is responsible for gathering all manufacturer panel equipment data.

2.02 SHORT CIRCUIT STUDY AND PROTECTIVE DEVICE EVALUATION STUDY

A. The short circuit study shall be performed with the aid of a digital computer program, and shall be in accordance with ANSI C37.5-1969 (R1975), IEEE std. 320-l72, IEEE 339, IEEE 242 and IEEE std. 141-1976.

B. The study input data shall include the power company's short circuit contribution, resistance and reactance components of the branch impedances, the X/R ratios, base quantities selected, and other source impedances.

C. Calculate phase and phase-to-ground current and impedance.

D. Short circuit close and latch momentary duty values and interrupting duty values shall be calculated on the basis of assumed three-phase bolted short circuits at each switchgear bus, medium voltage controller, switchboard, low voltage motor control center, distribution panelboard, pertinent branch circuit panel, and other significant locations through the system. The short circuit tabulations shall include symmetrical fault currents and X/R ratios. For each fault location, the total duty on the bus, as well as the individual contribution from each connected branch, shall be listed with its respective X/R ratio and impedance.

E. A protective device evaluation study shall be performed to determine the adequacy of circuit breakers, molded case switches, automatic transfer switches, manual transfer switches, and fuses by tabulating

and comparing the short circuit ratings of these devices with the calculated fault currents. Appropriate multiplying factors based on system X/R ratios and protective device rating standards shall be applied. Any problem areas or inadequacies in the equipment due to short circuit currents shall be promptly brought to the Engineer's attention, and corrective measures implemented at no extra cost to the Owner.

2.03 PROTECTIVE DEVICE COORDINATION STUDY

A. A protective device coordination study shall be performed to provide the necessary calculations and logic decisions required to select or to check the selection of power fuse ratings, protective relay characteristics and settings, ratios, and characteristics of associated current transformers, and low voltage breaker trip characteristics, and settings.

B. The coordination study shall include all medium and low voltage classes of equipment from the building or plant service protective devices down to and including the largest rated device in the MCC low voltage motor control center and panelboard. The phase and ground overcurrent protection shall be included, as well as settings of all other adjustable protective devices.

C. The undervoltage relay setting shall be carefully selected in order to override momentary voltage drop conditions. In addition, a time delay relay shall be used to help override undervoltage conditions. Switchgear manufacturer shall coordinate with utility company to determine a suitable relay setting and time delay setting to override the distribution system normal/abnormal voltage drop conditions.

D. The time-current characteristics of the specified protective devices shall be drawn on Keuffel and Esser log-log paper. The plots shall include complete titles, representative one-line diagram and legends, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves, and fuses. The coordination plots shall include the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing inrush and ANSI transformer withstand limits, and significant symmetrical and asymmetrical fault currents. All restrictions of the National Electrical Code shall be adhered to and proper coordination intervals and separation of characteristic curves shall be maintained. The coordination plots for phase and ground protective devices shall be provided on a system basis and on separate log sheets. A sufficient number of separate curves shall be used to clearly indicate the coordination achieved.

E. The selection and settings of the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios and connection, manufacturer and type, range of adjustment, and recommended settings. A tabulation of the recommended power fuse selection shall be provided for the medium voltage fuses where applied in the system. Any discrepancies, problem areas, or inadequacies shall be promptly brought to the Engineer's attention.

F. The coordination study shall be calculated by means of computer software package.

2.04 ARC FLASH HAZARD STUDY

A. Perform an arc flash hazard study after the short circuit and protective device coordination study has been completed based upon IEEE Std 1584, "IEEE Guide For Performing Arc Flash Hazard Calculations."

B. The maximum are Flash protection boundary allow inside building shall be limited to a category 3 if the rating is found to be higher than Category 3, Electrical Equipment shall be modified to reduce the incident energy level to a Category 3.

C. The study shall be calculated by means of computer software package. Pertinent data, rationale employed, and assumptions in developing the calculations shall be incorporated in the introductory remarks of the study.

D. The study shall be in accordance with applicable NFPA 70E, OSHA 29-CFR, Part 1910 Sub part S and IEEE 1584 Standards.

E. Determine the following

1. Flash Hazard Protection Boundary.
2. Incident Energy.
3. Working Distance.
4. Required PPE Level.
5. Shock Hazard Voltage.
6. Limited Approach.
7. Restricted Approach
8. Prohibited Approach.

F. Produce an Arc Flash Warning label listing items 1-8 above arc flash label size shall be 3"x3" minimum. Also include the bus name, system operating voltage, and date of issue. Labels shall be printed in color and be printed on adhesive backed labels. See example below. Provide a minimum 3" x 3" Label.

G. Produce Bus Detail sheets that list the items D 1-8 from above and the following additional items.

1. Bus Name.
2. Upstream Protective Device Name, Type, and Settings.
3. Bus Line to Line Voltage.

H. Produce Arc Flash Evaluation Summary Sheet listing the following additional items:

1. Bus Name.
2. Upstream Protective Device Name, Type, and Settings

3. Bus Line to Line Voltage.
4. Bus Bolted Fault.
5. Protective Device Bolted Fault Current.
6. Arcing Fault Current.
7. Protective Device Trip / Delay Time.
8. Breaker Opening Time.
9. Solidly Grounded Column.
10. Equipment Type.
11. Gap.
12. Arc Flash Boundary.
13. Working Distance.
14. Incident Energy.
15. Required Protective Fire Rated Clothing Type and Class.

2.05 COMPUTER SOFTWARE DEVELOPERS

A. EDSA, SKM System Analysis Inc. or Engineer approved equal.

PART 3- EXECUTION

3.01 PROTECTIVE DEVICE TESTING, CALIBRATION, AND ADJUSTMENT

A. The equipment manufacturer shall provide the services of a qualified field Engineer and necessary tools and equipment to test, calibrate, and adjust the protection relays and circuit breaker trip devices as recommended in the power system study.

B. As a part of this Contract, the manufacturer's system Engineer shall make one formal presentation in the Owner’s office to the Owner's personnel. The presentation shall include all training materials and visual aids.

END OF SECTION 16055

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SECTION 16060

ACCEPTANCE TESTING AND CALIBRATION

PART 1- GENERAL

1.01 WORK INCLUDED

A. This section provides the guidelines for testing of electrical equipment, cable, protective relays, circuit breakers, motor control centers, motors, and related apparatus to be used for the site interior and exterior electrical distribution system. This specification does not release the Contractor or vendor from any further testing required for safe commissioning of the equipment. All tests shall be completely recorded on forms provided at the end of this section. Tests shall be submitted to Engineer/Owner for approval.

B. Contractor will provide and pay the cost of electrical testing by an independent testing firm. Testing firm shall have a minimum of five years of experience in providing acceptance testing for water/wastewater utilities. Testing shall be performed per the latest InterNational Electric Testing Association Standards (NETA) standard. This cost will be included in the Contract Bid.

C. The Contractor shall immediately correct all deficiencies discovered during testing by the independent firm. The independent testing firm has the final say on the acceptance of the equipment, if testing determine the equipment is deficient, contractor shall be responsible to fix the deficiency even if the manufacturer said the equipment is satisfactory.

D. The Contractor to update the protective device settings with the final power system study acceptance.

1.02 REFERENCE STANDARDS

A. InterNational Electric Testing Association Standards (NETA) for acceptance testing of Electrical Distribution Apparatus, Publication 2.001, and IEEE Publication No. 141, are hereby made a part of this section, unless otherwise modified herein.

B. Related equipment specification in all section of Division 16.

C. NETA Maintenance Testing Specifications for electrical power distribution equipment and system (latest edition).

1.03 SUBMITTAL

A. The testing result shall be summarized in a final report certified by the testing technician. Report shall be submitted per division 1 requirement.

B. The report shall include the following section:

1. Description, purpose, basis and scope of the work.

2. Field data sheet showing all visual, mechanical and electrical inspection done on the equipment. The data sheet shall show check mark and values of all the testing done, a description of the instrument used for testing.

3. A summary of the deficiency, concern, repairs and recommendation.

4. A table showing the final settings of all the adjustable equipment tested.

5. All the testing values shall be in accordance with the latest NETA standard.

6. Provide calibration certificate of all devices used for testing, devices shall be specifically approved for the test.

C. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.

D. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

PART 2- PRODUCTS - NOT APPLICABLE

PART 3- EXECUTION

3.01 TESTS

A. All tests, other than Low Voltage Systems and Equipment, shall be supervised by the Engineer/Owner and the contractor. Contractor shall give a one week notice of all scheduled tests to the Engineer/Owner in writing.

B. Contractor shall notify the Engineer/Owner of scheduled dates of electrical equipment installation completion. Equipment testing shall be coordinated at this time by Contractor with Engineer/Owner and appropriate Manufacturer's Representatives.

C. Under this specification the Contractor shall perform the electrical tests on specified equipment and as specified under Part 3, Execution. The Contractor shall supply all equipment required to perform all testing responsibilities.

3.02 EXECUTION

A. PREPARATORY WORK

1. Prior to the testing of any specific piece of equipment, the Contractor shall remove all shipping hardware and inspect for broken or missing parts and proper connections in accordance with the manufacturer's instructions.

B. Visual and Mechanical Inspection

1. Prior to any electrical testing Contractor shall perform a visual and Mechanical inspection as specified in the latest NETA standard.

3.03 DEVICE

A. Air switches – Low voltage

1. Electrical Tests

a. Perform insulation-resistance tests on each pole, phase-to- phase and phase-to-ground for one (1) minute. Test voltage and minimum resistances should be in accordance with NETA Standard.

b. Perform contact-resistance test across each switch blade and fuse holder, or perform thermographic survey in accordance with the lastest NETA Standard.

B. Transformers – Dry-type

1. Small Transformers: Dry-Type, Air-Cooled (600 Volt and Below) (less than 100 kVA single-phase or 300 kVA three-phase)

a. Inspect for physical damage, broken insulation, tightness of connections, defective wiring, and general condition.

b. Thoroughly clean unit prior to making any tests.

c. Perform insulation-resistance test. Calculate polarization index. Measurements shall be made from winding-to-winding and windings-to-ground. Test voltages and minimum resistance shall be in accordance with NETA Standard. Results to be temperature corrected in accordance with NETA Standard.

d. Verify that the transformer is set at the specified tap.

C. Megger Tests – low-voltage, 600V maximum

1. Use a minimum 500 volt megohmmeter.

2. Take each reading for at least one minute.

3. Include the following tests:

a. 115 and 230 volt motors..... 5.0 Megohms

b. 460 volt motors..... 7.0 Megohms

c. 600 volt wiring up to 1000 ft..... 25.0 Megohms

D. Test all wiring including main service feeders, motor feeders and branch circuit wiring.

E. Surge Arresters, Surge Protection Devices(Low Voltage):

1. Electrical Tests

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable, in accordance with NETA Standard.

b. Perform an insulation-resistance test at voltage levels in accordance with NETA Standard.

c. Test grounding connection in accordance with NETA Standard.

F. Grounding Systems

1. Take ground resistance measurements in normally dry weather, not less than 48 hours after rainfall, with the ground under test isolated from other grounds.

2. Measure the resistance of each ground rod. Submit in writing to the OWNER a record indicating the rod location, the resistance measured and the soil condition at the time.

3. Take ground resistance measurements on the building water service where it is used as a ground also.

4. Install additional grounding if the resistance to ground measures more than 25 OHM's at any location.

G. Emergency System Transfer Switches

1. Electrical Tests

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable, in accordance with latest NETA Standard

b. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be one minute. For units with solid-state components or for control devices that can not tolerate the applied voltage, follow manufacturer's recommendation.

c. Perform a contact/pole-resistance test.

d. Verify settings and operation of control devices.

e. Calibrate and set all relays and timers in accordance with latest NETA Standard.

f. Verify phase rotation, phasing, and synchronized operation as required by the application.

g. Perform automatic transfer tests:

(i) Simulate loss of normal power.

(ii) Return to normal power.

(iii) Simulate loss of emergency power.

(iv) Simulate all forms of single-phase conditions.

h. Verify correct operation and timing of the following functions:

(i) Normal source voltage-sensing relays.

(ii) Engine start sequence.

(iii) Time delay upon transfer.

(iv) Alternate source voltage-sensing relays.

(v) Automatic transfer operation.

(vi) Interlocks and limit switch function.

(vii) Time delay and retransfer upon normal power restoration.

(viii) Engine cool down and shutdown feature.

H. Emergency Systems, Engine Generator

1. Electrical and Mechanical Tests

    a. Test generator in accordance with latest NETA Standard.

    b. Test protective relay devices in accordance with latest NETA Standard

    c. Perform phase-rotation test to determine compatibility with load requirements.

    d. Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.

    e. Perform vibration test for each main bearing cap.

    f. Conduct performance test in accordance with ANSI/NFPA 110.

    g. Verify correct functioning of governor and regulator.

I. Motor Testing

1. Megger test motors for insulation and stator winding resistance.

2. Dry out any wet insulation by use of space heaters or other approved methods.

3. Check coupling alignment, shaft end play, lubrication and other mechanical checks as required. Follow manufacturer's instructions.

4. Check for proper rotation.

5. Combined or coupled motor and pump vibration testing under actual pumping conditions. .

J. Receptacles

1. Test all receptacles for proper connections and grounding. Use an approved plug in tester.

K. Control Circuits

1. Check all circuits for continuity, proper connection and proper operations.

2. Set all time delay relays and timers for the desired operation. Record the settings, indicating the relay or timer, its location and the setting used. Verify all settings with a stopwatch.

L. Lighting

1. Turn on all lights after lamping them with new lamps.

2. Turn on all lights at each panelboard with lights on and submit typewritten results to the OWNER. Results to include panelboard number and location, branch circuit number and load served, and amperage reading.

3. Allow outdoor lights to remain on for 72 hours to check ballasts as well as lamps. Replace any defective material.

M. Motor Starters

1. Set all motor circuit protectors, all feeder circuit breakers and all overload relays.

2. Record the following information and submit the same to the ENGINEER for checking:

   a. Load served and location.

   b. Full load amps.

   c. Locked rotor amps.

   d. Overload heater unit used.

   e. Overload relay setting used.

   f. MCP setting used.

3. Take and record amperage readings on all feeders and motors to ensure proper phase balance.

N. Controls and Instrumentation

1. Test controls and instrumentation for continuity and proper operation. Comply with Section 16951.

2. Calibrate, set and test instruments in accordance with the Instrument Supplier's published recommendations.

3. Provide written records of all tests. Include certifications and settings for all instruments.

PART 4- MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

A. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this item will not be measured or paid for directly, but shall be considered subsidiary to the various bid items of the contract.

END OF SECTION 16060

SECTION 16073

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1- GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.

2. Construction requirements for concrete bases.

1.02 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified Professional Engineer licensed in the state where the project shall be built, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension and shear force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of 3 times the applied force.

1.03 SUBMITTALS

A. Product Data: 316 stainless steel slotted support systems.

B. Record data: Signed and sealed by a qualified professional engineer Licensed in the state where the project is constructed. Show fabrication and installation details and include calculations the dead load, live load, wind and allowable capacity for the following:

1. Trapeze hangers. Include Product Data for components.

2. Type 316 stainless steel slotted channel system and all bolts to be type 316ss.

3. Equipment supports and connections detail.

C. Welding certificates.

D. Field Test Report.

E. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.

F. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

1.04 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.05 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2- PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Use only stainless steel 316 components for support, anchorage and attachment components.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit.

b. Cooper B-Line, Inc.; a division of Cooper Industries.

c. ERICO International Corporation.

d. GS Metals Corp.

e. Thomas & Betts Corporation.

f. Unistrut; Tyco International, Ltd.

g. Wesanco, Inc.

2. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported.

E. Structural Steel for Fabricated Supports and Restraints: 316 Stainless Steel only.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Adhesive Anchor Systems: Wedge-type 316 Stainless Steel, for use in hardened portland cement concrete, with tension and shear capacities appropriate for supported loads and building materials where used.

    a. Manufacturers: Hilti Inc. only.

2. Concrete Inserts: 316 Stainless Steel, Slotted support system units.

3. Clamps for Attachment to Steel Structural Elements: 316 Stainless Steel, type suitable for attached structural element.

4. Through Bolts: Structural type, hex head, and high strength. 316 Stainless Steel Toggle Bolts: 316 Stainless Steel.

5. Hanger Rods: 316 Stainless Steel.

G. Cast aluminum one-hole clam conduit supports are not acceptable.

2.02 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 5 Section "Metals" for 316 Stainless Steel shapes and plates.

C. All outdoor equipment rack shall be provided with canopy to protect the equipment for being overheated by the sun. Canopy be provided per detail drawings.

PART 3- EXECUTION

3.01 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for conduit as required by NECA 1 Table 1 when the maximum spacing is less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with 316 Stainless Steel slotted support system, sized so capacity can be increased by at least 25 percent (1conduit site miniumum) in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. 316 Stainless Steel clamps designed for supporting single conduits may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.02 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. All supports and fastening devices shall be stainless steel 316.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 300 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.

2. To New Concrete: Adhesive Anchor Bolt.

3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4. To Existing Concrete: Adhesive Anchor System provided with lock washers and nuts shall be used in existing normal weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete slabs or wall less than 4 inches thick.

5. Expansion Anchor Bolt can be used for concrete thickness is less than 4 inches to meet minimum

6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts

7. To Light Steel: Sheet metal screws.

8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panel boards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint wind strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations to avoid reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 5 Section "Metals" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.04 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 6 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 4000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3. Install anchor bolts according to anchor-bolt manufacturers written instructions.

3.05 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 9 “Finishes” for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair coating to comply with ASTM A780.

3.06 INSTALLATION

A. Mounting Stands: Field mounted disconnects, pushbutton control stations, etc, shall be mounted on steel stands as shown on the Drawings. Where clearance requirements for stands may not be maintained, the Engineer may direct equipment to be wall-mounted adjacent to the drive, but in no case shall the distance from the drive motor to the control station exceed 3-ft.

END OF SECTION 16073

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SECTION 16110

RACEWAYS

PART 1- GENERAL

1.01 WORK INCLUDED

A. This section specifies the furnishing and installation of electrical raceway systems.

1. Conduit:
    a. Rigid aluminum conduit.
    b. PVC-coated rigid aluminumconduit.
    c. Liquid-tight flexible metal conduit.
    d. PVC Schedule 40 conduit.
2. Wireways.

1.02 REFERENCE STANDARDS

A. The following standards shall apply as if written here in their entirety:

1. ANSI C80.5 - American National Standard for Electrical Rigid Aluminum Conduit (ERAC)
2. UL 1 - Safety Standard for Flexible Metal Conduit
3. UL 5 - Safety Standard for Surface Metal Raceways and Fittings
4. UL 651 - Standard for Schedule 40 and Schedule 80 Rigid PVC Conduit and Fittings
5. UL 870 - Safety Standard for Wireways, Auxiliary Gutters, and Associated Fittings
6. NEMA RN 1 - PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing
8. UL 6 and 614 - Electrical Rigid Metal Conduit
9. UL 360 - Liquid-tight Flexible Steel Conduit
10. UL 467 - Electrical Grounding and Bonding Equipment
11. National Electric Code
12. National Fire Protection Association (NFPA 70E)

1.03 SUBMITTALS

A. Submit to the Engineer, in accordance with Division 1, detailed catalog information or drawings describing electrical and physical characteristics of all equipment specified.

B. Submittal shall be clearly marked showing only equipment provided. Mark through equipment option not provided.

C. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.

D. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

PART 2- PRODUCTS

2.01 MATERIALS

A. Rigid Aluminum Conduit:

1. Conduit: Rigid copper free aluminum (alloy 6063-T1) conduit (RAC).

2. Fittings: For RAC use threaded aluminum.

3. Listing: UL 6A.

4. Acceptable RAC Manufacturers: Allied Tube and Conduit, Consolidated Aluminum Corporation, Kaiser, V.A.W., Reynolds.

5. Acceptable Fittings Manufacturers: Appleton, Crouse-Hinds, Midwest, OZ/Gedney, Raco and listed conduit manufacturers.

B. PVC-Coated Rigid Aluminum Conduit:

1. Conduit: Rigid aluminum conduit plus a factory-applied, 40-mil-thick covering of polyvinyl chloride (PVC) bonded to the metal, and 2 mil polyurethane coating on the inside.

2. Fittings: Same as aluminum conduit fittings plus a factory-applied, 40-mil-thick covering of polyvinyl chloride (PVC) bonded to the metal.

3. Listing: UL 6.

4. Acceptable Conduit and Fittings Manufacturers: Killark, KorKap, OCAL, Perma-cote, Plasti-bond and Robroy Industries.

C. Liquid-tight Flexible Metal Conduit:

1. Conduit: Spiral-wound, square-locked, aluminum plus a bonded outer jacket of PVC.

2. Fittings: Compression sealed type aluminum.

3. Listing: UL 360 for conduit and UL 467 for fittings.

4. Acceptable Conduit Manufacturers: Allied tube and Conduits, Anaconda, Anamet, Liquatite.

5. Acceptable Fittings Manufacturers: Appleton, Crouse-Hinds, Midwest, OZ/Gedney, Raco, and listed conduit manufacturer.

D. PVC Schedule 40 Conduit:

1. Non-metallic rigid conduit made of polyvinyl chloride (PVC) manufactured in accordance with the National Electrical Code UL 651 and NEMA TC-2.

2. Fittings shall also be non-metallic.

3. Acceptable conduit and fittings manufacturers: Allied Tube and Conduit, Carlon, CertainTeed Products, Electri-Flex, Heritage Plastics Central.

E. Explosion Proof Seal and Fitting

1. Conduit seal: Explosion proof, aluminium conduit filling with fiber and compound as define by NEC Article 500 and as manufactured by Crouse -Hinds or Appleton.

2. Explosion proof fittings: aluminium fittings; flexible coupling to match the hazard as defined by NEC Article 500 and as manufactured by Appleton or Crouse-Hinds.

3. Explosion proof conduits and fillings shall be rated for 40% fill.

F. Bushing: High impact, thermosetting, phenolic insulation; 150 degrees C; as manufactured by Appleton "BBUH", Blackburn, or OZ Gedney type A.

G. Ground bushings: Conduit grounding bushings shall consist of a insulated throat conduit bushing with an attached aluminum set screw lug. Grounding bushing shall comply with Fed. Spec. W-F-408b and W-W-C581d, UL Standards 514B and 467, and shall be Crouse Hinds Lazy Lug or approved equal.

H. Locknuts: Stainless Steel as manufactured by Appleton.

I. Hubs:

1. Cast aluminum, with broad flat surfaces with gripping teeth on both sides of conduit entry. Hub portion on exterior side of entry shall contain "O" ring for watertight seal of conduit entry. Hubs shall be Myers Hub, Appleton or Efcor.

J. Conduit through-wall and floor seal: PVC coated malleable [iron] [aluminum] body with oversized sleeves, sealing ring, pressure clamp and rings and sealing grommet; hex head cap screw, as manufactured by OZ Gedney, type FSK.

K. Smoke and fire seals: Material shall be intumescent, one (1) part (requiring no mixing) and capable of expanding up to a minimum of eight (8) times. Material shall be U.L. classified with a fire rating equal to or greater than the penetrated number. Products to be in caulk, putty, wrap strip, sheet, or access kit foam and shall be 3M "Fire Barrier".

L. Conduit drains: Conduit drains shall be Crouse Hinds ECD Universal, or approved equal.

M. Expansion Joints: Hot-dipped, galvanized, malleable iron with bonding jumpers. Linear expansion fittings shall be OZ Gedney Zx for rigid, metal conduit or Appleton "XJ" series. Combination linear and deflection expansion fittings shall be OZ Gedney type AXDX.

N. Threaded nipples: As manufactured by Allied, Triangle or Steel Duct. Conduit nipples shall have two (2) independent sets of threads. Running threads shall not be used. Utilize the conduit union when joining two (2) fixed conduits in a continuous run.

O. Escutcheons: Chrome-plated, sectional floor and ceiling plates, as manufactured by Crane No. 10.

P. Accessories: Reducers, washer, etc., shall be stainless steel.

Q. Weatherheads: Weatherheads shall be threaded aluminum for threaded rigid conduit application and shall not be a clamp type. Weatherheads shall be Crouse Hinds series F, O-Z type 17 or Appleton Series F.

PART 3- EXECUTION

3.01 CONDUIT AND FITTINGS

A. Minimum Trade Size: 3/4 inch, except that 1/2-inch flexible metal conduit may be used in lengths not exceeding 72 inches for tap conductors supplying lighting fixtures and for switch legs. The minimum size for underground conduit shall be 1½" inch.

B. Conduit sizes, where not indicated, shall be N.E.C. code-sized to accommodate the number and diameter of wires to be pulled into the conduit.

C. Plastic coated metallic conduit lengths shall be joined with threaded metallic coupling that shall be each equipped with a 40 mil thickness sleeve that shall extend over the threads of the joined conduit. Each joint shall be watertight.

D. Conduit runs made in concrete pours or surface-mounted runs that are attached to the structure, shall be equipped with an expansion/deflection fitting where they cross an expansion joint, and at every 100 feet.

E. All conduit runs shall be watertight over their lengths of run. Slope conduits such that they drain, and install drain fitting as required to remove condensation from the conduit.

F. Install a drain fitting for all conduits subject to condensation. Condensation water shall never enter electrical or instrumentation enclosure.

G. Plastic jacketed flexible metal conduit shall be used to connect wiring to motors, limit switches, bearing thermostats, and other devices that may have to be removed for servicing. Unless otherwise indicated, maximum lengths of flex shall be thirty (30”) inches.

H. All raceways shall be swabbed clean after installation. There shall be no debris left inside. All interior surfaces shall be smooth and free from burrs and defects that would injure wire insulation.

I. Application of Conduit Types:

1. All underground conduit including conduits under a concrete slab shall be PVC and shall be concrete encased. Shall be as specified under Section 16360 Underground Duct Banks.

2. Provide PVC coated rigid aluminum, conduit bends for all PVC conduits bends. Only factory bended long sweep elbow are acceptable.

3. Exposed conduits inside dry ventilated areas, outdoors in non-corrosive atmosphere shall be rigid aluminum. Aluminum shall not come in contact with concrete at any point.

4. Exposed conduits in areas where chemicals are stored, handled, or utilized the conduit shall be PVC coated aluminum.

5. Exposed conduits in high humidity, non-ventilated areas, constant or frequency wet areas, corrosive atmosphere areas the conduit shall be PVC coated aluminum.

6. At the transition from PVC to rigid aluminum conduit, provide a 12" section of PVC coated aluminum conduit with a minimum of 6-inches into the concrete. The PVC coated aluminum conduit shall be per the specification, field wrapping or applying by spray shall not be acceptable.

J. Holes for raceway penetration into sheet metal cabinets and boxes shall be accurately made with an approved tool. Cutting openings with a torch or other device that produces a jagged, rough cut will not be acceptable.

K. Preparation:

1. Place conduit or sleeves in the forms of walls and floor slabs for the free passage of wire or conduits.

2. Set conduit or sleeves in place a sufficient time ahead of concrete placement so as not to delay the work.

3. Apply sealing methods for sleeves through floors and through exterior walls, per details shown on plans.

4. Plugs or caps shall be installed before concrete placement begins.

L. Installation Requirements:

1. Metallic Conduits:

a. Continuous between enclosures such as outlet, junction and pull boxes, panels, cabinets, motor control centers, etc.

b. The conduit must enter and be secured to enclosures so that each system is electrically continuous through out.

c. Where knockouts are used, provide double locknuts, one on each side.

d. At conduit terminations, provide insulated bushings for conductor protection.

e. Where conduits terminate in equipment having a ground bus, such as in switchgear, motor control centers and panelboards, terminate conduit with an insulated grounding bushing and extend a suitable grounding wire to the ground bus.

f. Hubs of the same material shall be used at conduit termination.

2. Run concealed conduit as directly and with the largest radius bends as possible.

3. Run exposed conduit parallel or at right angles to building or other construction lines in a neat and orderly manner. Conceal conduit in finished areas. Unless otherwise shown, remaining conduit may be exposed.

4. Provide chrome-plated floor and ceiling plates around conduits exposed to view and passing through walls, floors, partitions, or ceilings in finished areas.

5. Select properly sized plates to fit the conduit when securely locked in place.

M. Installation Methods:

1. Install each entire conduit system complete before pulling in any conductors.

2. Clean the interior of every run of conduit before pulling in conductors to guard against obstructions and omissions.

3. Cut all joints square, then thread and ream smooth.

4. Bends:

   a. Make bends with standard elbows or conduit benders in accordance with the NEC.

   b. Make field bends using equipment designed for the particular conduit material and size involved. Particularly PVC coated so as not to damage coating

   c. PVC coated field bend not acceptable.

   d. Bends must be free from dents or flattening.

   e. Use no more than the equivalent of three 90-degree bends in any run between terminals and cabinets, or between outlets and junction boxes or pull boxes.

5. Conduit bodies may be used in lieu of conduit elbows where ease of installation and appearance warrants their use. Conduit bodies larger than 1-inch may be used only where approved.

6. Fastenings: Securely fasten and support exposed conduit to framing using stainless steel unistrut and straps of same material as unistrut with 316 stainless steel fastening hardware.

7. Provide a No. 30 nylon pulling line in conduits in which wiring is not installed under this work, such as telephone, signal, and similar systems. Identify both ends of the line by means of labels or tags reading "Pulling Line." Also, state the panel the conduit originated from. Apply write-on identification to empty conduits to identify each conduit as to terminus of other end and also to identify trade size of conduit.

8. Suitably cap conduit during construction to avoid water, dirt and trash entrance.

9. Use expansion-deflection fittings on conduit crossing structural expansion joints and on exposed conduit runs of more than 100 feet or where necessary. Provide bonding jumpers across fittings in metal raceway systems. Conduit runs made in concrete pours or surface-mounted runs that are attached to the structure, shall be equipped with an expansion/deflection fitting where they cross an expansion joint, and at every 100 feet.

10. Use expansion-deflection fittings on all conduit runs that transition from underground to above ground within 12” of grade level.

11. With a coupling, terminate concealed conduit for future use at structural surfaces. Install a pipe plug flush with the surface.

12. Openings around electrical penetrations of fire-resistance rated walls, partitions, floors or ceilings shall maintain the fire resistance rating using approved methods. See NEC 300-21. Fire barrier shall be 3M 2001 RW silicone RTV foam or approved equal.

13. Conduits shall be installed with uniform slope which will permit drainage toward manholes, pull boxes, or building walls. Utilize conduit drain as require to remove condensate in the conduits.

14. Seal all conduits with pliable sealant such as "Duraseal" where entering boxes, manholes, switchgear, motor control centers, panelboards, enclosures, etc.

15. PVC coated conduit shall be installed by certified installer. PVC coated conduit installation shall follow manufacturer recommendation.

16. All termination at an enclosure shall be made from the bottom of the enclosure, no overhead penetrations are allowed. When conduits are located above the enclosure route the conduit at the same height as the bottom of the enclosure, install a drip lane at the end of the conduit and use flexible conduit to terminate at the bottom of the enclosure.

N. Hazardous Areas

1. Install conduit seals at all penetrations to hazardous area, as define by the NEC. Install additional seal-type fittings within the hazardous area in accordance with the requirements of the NEC Article 500.

2. Install dam and sealing compound per the Seal Manufacturer's instructions.

3. Provide flexible conduit which is listed for use in hazardous areas. Conduit, flexible conduit fittings and all other materials shall be listed for use in Class 1, Division 2 Group D atmosphere.

3.02 WIREWAYS

A. Installation

1. Install wireways, where shown, according to NEC Articles, 376 and 378.

2. Limit capacity to a maximum of thirty (30) current carrying conductors including neutrals at any cross section of the wireway with 20% conductor fill at any cross sectional area.

END OF SECTION 16110

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SECTION 16120

CONDUCTORS - 600V AND BELOW

PART 1- GENERAL

1.01 WORK INCLUDED

A. Furnish and install, complete and ready for operation, electrical conductor systems as shown on the drawings and as specified herein.

1.02 SUBMITTALS

A. Submit shop drawings and product data as per Division 1 - General Provisions, showing all details of materials.

B. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.

1.03 CONDUCTOR COLOR CODING

A. Color-coding of multi-conductor control and instrumentation cable is specified in the individual cable type specification.

B. For power conductors, provide all single conductors power cables with integral insulation pigmentation of the designated colors, except conductors larger than No. 6 may be provided with color-coding by wrapping the conductor at each end and at all accessible locations with vinyl tape. Where this method of color-coding is used, wrap at least six full overlapping turns of tape around the conductor covering an area 1-1/2 to 2 inches wide at a visible location.

C. Phase A, B, and C implies the direction of positive phase rotation.

D. Use owner's current color scheme. If owner does not have a consistent color scheme use the following:

E. Use the following colors:

System	*Conductor*	*Color*
All Systems	Equipment Grounding	Green
240/120 Volts	Grounded Neutral	White
1-Phase, 3-Wire	One Hot Leg	Black
	Other Hot Leg	Red
240,208/120 Volts	Neutral	White
3-Phase, 4-Wire	Phase A	Black
	Phase B	Red
	Phase C	Blue
	Ground	Green
480Y/277 Volts	Neutral	White
3-Phase, 4-Wire	Ground	Green
	Phase A	Purple
	Phase B	Brown
	Phase C	Yellow
24Vdc	Positive	Blue
	Negative	White w/blue

PART 2- PRODUCTS

2.01 GENERAL

A. Use the manufacturer's name, model or catalog number, if for the purpose of establishing the standard of quality and general configuration desired only.

B. Splices are not acceptable on this project, except at light fixtures and receptacles.

2.02 CONDUCTORS - 600 VOLTS

A. Single Conductors 600 Volts and Below:

1. Unless otherwise indicated, all conductors shall be copper and shall be stranded. Solid conductors shall not be used. All conductors with the exception of grounding conductors shall be standard copper.

2. Utilize only conductors meeting applicable requirements of UL 44, UL 1685, IECA S-95-658 (NEMA WC70).

3. Provide conductors with type XHHW insulation except for tray cable. Tray cable shall be type XHHW-2 insulation.

4. Unless noted otherwise, conductor sizes indicated are based on copper conductors. Do not provide conductors smaller than those indicated.

5. Where flexible cords and cables are specified, provide Type STJO, 600 volt, with the number and size of copper conductors indicated.

6. Single Pair (600 Volt No. 16 AWG Twisted, shielded Pair Instrumentation Cable, Type TC):

   a. General: Single pair instrumentation cable designed for noise rejection for process control, computer, or data log applications. Suitable for installation in cable trays, conduit, or other approved raceways. Minimum cable temperature rating shall be 90° C dry locations, 75° C wet locations.

   b. Individual Conductors: Soft annealed copper, Class B, 7-strand concentric per ASTM B8, 22 AWG, 7-strand copper tinned drain wire.

   c. Insulation and Jacket: Each conductor XHHW-2. Pair conductors pigmented black and white. Jacket flame-retardant and sunlight and oil resistant PVC with 45 mils nominal thickness. Shield aluminum/mylar overlapped to provide 100 percent coverage.

   d. Dimension: 0.30 inch nominal OD.

   e. Manufacturers: Alpha Wire Corporation, Belden, General Cable, The Okonite Company.

7. Single Triad (600 Volt No. 16 Twisted, Shielded Triad Instrumentation Cable, Type TC):

   a. General: Single triad instrumentation cable designed for noise rejection for process control, computer, or data log applications. Suitable for installation in cable tray, conduit, or other approved raceways. Minimum cable temperature rating shall be 90° C dry locations, 75° C wet locations.

b. Conductors: Soft annealed copper, Class B, 7-strand concentric per ASTM B8, 22 AWG, 7-strand copper tinned drain wire.

c. Insulation and Jacket: Each conductor, XHHW-2insulation. Triad conductors pigmented black, red, and white. Jacket flame-retardant and sunlight and oil retardant PVC with 45 mils nominal thickness. Shield aluminum/mylar, overlapped to provide 100 percent coverage.

d. Dimensions: 0.32-inch nominal OD.

e. Manufacturers: Alpha Wire Corporation, Belden, General Cable, The Okonite Company.

8. Equipment Grounding Conductors:

a. Provide stranded copper conductors, as indicated or as required by NEC, for equipment grounding. All grounding conductor shall be stranded copper.

b. Provide conductors with green Type XHHW insulation with a minimum thickness of 1/32-inch.

B. Multi-conductors, Multi-pairs, or Multi-triads not acceptable.

PART 3- EXECUTION

3.01 GENERAL

A. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii. Pulling compound shall be used. Use only UL listed compound compatible with the cable outer jacket and with the raceway involved.

B. CONTRACTOR is to provide and install all low voltage (120V, 208V, 480V, etc.) distribution equipment and hardware associated with this project as shown on the plan drawings.

C. Tighten screws and terminal bolts using torque type wrenches, and/or drives, to tighten to the inch-pound requirements of the NEC and UL.

D. Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means such as arc and fireproofing tapes, bundle throughout their exposed length conductors entering from each conduit with nylon, self-locking, releasable, cable ties placed at intervals not exceeding 12 inches on centers.

3.02 CONDUCTOR - 600 VOLTS AND BELOW

A. Provide conductor sizes as indicated on the drawings.

B. Minimum size for control shall be #14 for individual wire and #16 TSP, TST. Minimum size for power cables shall be #12. Provide only single pair and triad, multi-pair and triad not acceptable.

C. Use silicone filled pressure connectors. Place no more than one conductor in any single-barrel pressure connection.

D. Motors connector shall be crimp connectors or kernys varnish carbonic C130.

E. Soldered mechanical joints insulated with tape will not be acceptable.

F. Vinyl plastic insulating tape for wire and cable splices and terminations shall be flame retardant, 8.5-mil thick minimum, rated for 105°C minimum meeting the requirements of UL 510. Acceptable product 3M-Scotch 88.

G. Provide terminals and connectors acceptable for the type of material used.

H. Arrange wiring in cabinets, panels, and motor control centers neatly cut to proper length. Remove surplus wire, and bundle and secure in an acceptable manner. Identify circuits entering motor control centers or other control cabinets in accordance with the conductor identification system specified herein.

I. Terminate control and instrumentation wiring with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions. Where terminals provided will accept such lugs, terminate control and instrumentation wiring (except solid thermocouple leads) with insulated, locking-fork compression lugs, Thomas & Betts, Sta-Kon, or equal.

J. For terminals designed to accept only bare wire compression terminations, use only stranded wire, and terminate only one wire per terminal. Tighten terminal screws with torque screwdriver to recommended torque values.

K. Attach compression lugs with a tool specifically designed for that purpose which provides a complete, controlled, crimp where the tool will not release until the crimp is complete. Use of plier type crimpers is not acceptable.

L. Cap spare conductors and conductors not terminated with UL listed end caps.

M. Where conductors pass through holes or over edges in sheet metal, remove all burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

N. For conductors that will be connected by others, provide at least 6 feet spare conductor in freestanding panels, and at least 2 feet spare in other assemblies. Provide more spare conductor in any particular assembly where it is obvious that more conductor length will be needed to reach the termination point.

3.03 CABLES

A. Do not splice without permission of the ENGINEER. Locate splices, when permitted, only in readily accessible cabinets or junction boxes using terminal strips.

B. Where connections of cables installed under this section are to be made to instrumentation and controls, leave pigtails of adequate length for neat bundled type connections.

C. Maintaining the integrity of shielding of instrumentation cables is essential to the operation of the control systems. Take special care in cable installation to ensure that grounds do not occur because of damage to the jacket over the shield.

D. Cable Placement:

1. Immediately prior to the placement of each cable or cable group, inspect the raceway to determine that installation is complete and that the interior is clean and free of all materials detrimental to the cable or its placement. Group all cable assigned to a particular conduit and pulled simultaneously, using cable grips and acceptable lubricants.

2. Provide adequately sized raceways to accommodate the number and size of cable as specified, and in compliance with Article 300 of the National Electric Code. If at any time during the progress of

the work raceways appear inadequate to accommodate the assigned cable, notify the Engineer/Owner at once and discontinue further work on the questionable raceway until advised by the Owner as to how to proceed.

3. Carefully check all cable as to size and length before pulling into conduits. Remove and replace cable pulled into the wrong conduit or cut too short at no additional cost to the Engineer/Owner. Do not pull cable removed from one conduit or duct into another conduit or duct without permission of the Engineer/Owner.

E. Use woven wire cable grips to pull all low voltage single conductor cable, No. 2/0 and larger, and all low voltage multi-conductor cable. Use pulling loops to pull single conductor cable smaller than No. 2/0. When a cable grip is used for pulling, the arc of the cable covered by the grip plus 6-inches shall be cut off and discarded.

F. Insert a reliable non-freezing type of swivel or swivel connection between the pulling ropes and the cable eye, or grip to prevent twisting under strain.

G. Do not exceed the maximum pulling tension recommended by the cable manufacturer. Pulling mechanisms of both the manual and power types shall have the rated capacity in tons clearly marked on the mechanism. Whenever the capacity of the pulling mechanism exceeds the recommended pulling tension of the cable as given by the cable manufacturer, a dynamometer shall be used to show the tension on the cable, and the indicator shall be constantly watched. If any excessive strain develops, stop the pulling operation at once and determine and correct the difficulty.

3.04 CONDUCTOR ARC AND FIREPROOFING TAPES

A. Use arc and fireproofing tapes on 600 volt single conductors and cables, except those rated Type TC, throughout their entire exposed length at splices in manholes, handholes, vaults, cable trays, and other indicated locations.

B. Wrap together as a single cable conductors entering from each conduit.

C. Follow tape manufacturer's installation instructions. Secure the arc and fireproofing tape at frequent intervals with bands of the specified glass cloth electrical tape. Make each band of at least two wraps of tape directly over each other.

D. Arc and Fireproofing tape shall be 3M Scotch #77.

3.05 FIELD TESTS

A. Instrumentation Cables: After instrumentation cable installation and conductor termination by the instrumentation and control supplier, perform tests witnessed by the ENGINEER to ensure that instrumentation cable shields are isolated from ground, except at the grounding point. Remove improper grounds.

END OF SECTION 16120

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SECTION 16130

BOXES

PART 1- GENERAL

1.01 WORK INCLUDED

A. Furnish and install outlet boxes, floor boxes, junction boxes, pull boxes and terminal boxes.

B. All boxes located outdoors containing heat sensitive equipment shall be factory painted white.

1.02 REFERENCE STANDARDS

A. ANSI/NEMA Publication No. OS 1 - Cast Aluminum Outlet Boxes, Device Boxes, Covers and Box Supports, and Steel Covers.

B. ANSI/UL 514 - Electrical Outlet Boxes and Fittings.

C. National Electric Code.

1.03 SUBMITTALS

A. Submit to the Engineer, in accordance with Division 1, detailed catalog information or drawings describing electrical and physical characteristics of all equipment specified.

B. Submittal shall be clearly marked showing only equipment provided. Mark through equipment option not provided.

C. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

D. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.

PART 2- PRODUCTS

2.01 OUTLET BOXES

A. Flush Device Boxes:

1. Provide aluminum boxes of sufficient size to accommodate wiring devices to be installed at outlet.

2. Extension rings shall not be acceptable.

3. Square or rectangular boxes may be supplied.

4. Unless otherwise noted, provide boxes 3-1/2-inches deep by 4 inches wide.

5. Boxes in hazardous locations shall be NEMA rated for the application.

6. Boxes in contact with masonry or concrete shall be gray steel.

B. Exposed Device Boxes: Provide FD aluminum boxes for surface mounting in areas having exposed conduit systems. Provide gray steel boxes in areas in contact with masonry or concrete. Coordinate box cover for proper use.

C. Boxes for Lighting Fixtures:

1. Provide aluminum octagonal boxes with fixture stud supports and attachments as required to properly support ceiling and bracket-type lighting fixtures.

2. Unless otherwise noted, provide boxes 2 inches deep by 4 inches wide.

3. Boxes in contact with masonry or concrete shall be grey steel.

D. Masonry Boxes:

1. Provide stamp metal masonry boxes.

2. Use boxes with 1-gang capacity in excess of the number of devices to be installed.

3. Extension ring covers shall not be acceptable.

E. Listing: UL 514.

F. Acceptable Manufacturers: Appleton, Bowers, Crouse-Hinds, Efcor, Midwest, OZ/Gedney, RACO, Steel City, T & B.

2.02 JUNCTION, PULL AND SPLICE BOXES

A. Construction: Provide boxes conforming to NEC Article 314.

B. Interior Spaces: Provide surface mounted stainless steel type 316 boxes at least 4 inches deep.

C. Exterior Spaces: NEMA 4X stainless steel type 316 boxes at least 4 inches deep.

D. Embedded: Provide stainless steel 316 type with external recessed flanged cover when cast in concrete.

E. Listing: UL 514.

F. Acceptable Manufacturers: Hoffman, Keystone, OZ, Stahlin, Crouse-Hinds.

G. Hazardous location: Box shall be NEMA rated for the application.

2.03 TERMINATION CABINETS & BOXES

A. Termination cabinets shall be NEMA 4X 316 stainless steel gasketed. Cabinets shall be of sufficient size to adequately contain all terminals, wire-duct, and cables as determined by the CONTRACTOR. Cabinets shall have removable doors (lift-off) not more than 30 inches wide, and shall be equipped with a three-point locking latch handle.

B. Wire terminal blocks shall be Square D Type M Barrier Block system, or equal.

1. M4/6G or B 22014 AWG 6MM (.234 inch) wide, Grey, Blue, Single Level, 600 volt, 25 amp.

2. M6-8G or B 22-8AWG 8MM (.315 inch) wide, Grey Blue, Single Level, 600 volt, 55 amp.

C. The wire terminal block system shall be for DIN rail mounting, and shall include fuse/switch blocks, circuit breaker block, and isolation switches.

D. Acceptable Manufacturers: Hoffman.

PART 3- EXECUTION

3.01 PREPARATION

A. Coordinate location of all boxes with all other work.

B. Verify location of floor boxes with Engineer before installation.

3.02 OUTLET BOXES

A. Flush Boxes:

1. Unless otherwise indicated, mount all outlet boxes flush within 1/4-inch of the finished wall or ceiling line.

2. Securely fasten outlet boxes in position using clips or other suitable means.

3. Provide plaster covers for all boxes in plastered walls and ceilings.

B. Fixture Boxes: Where boxes for suspended lighting fixtures are attached to and supported from suspended ceilings, adequately distribute the load over the ceiling support members.

C. Mounting Height:

1. Mounting height of a wall-mounted outlet box means the height from finished floor to horizontal center line of the cover plate.

2. Where outlets are indicated adjacent to each other, mount these outlets in a symmetrical pattern with all tops at the same elevation.

3. Where outlets are indicated adjacent, but with different mounting heights, line up outlets to form a symmetrical vertical pattern on the wall.

4. Verify the final location of each outlet with Engineer before rough-in.

5. Remove and relocate any outlet box placed in an unsuitable location.

D. Back-to-Back Boxes:

1. Do not connect outlet boxes back to back unless approval is obtained.

2. Where such a connection is necessary to complete a particular installation, fill the voids around the wire between the boxes with sound insulating material.

E. Box Openings: Provide only the conduit openings necessary to accommodate the conduits at the individual location.

3.03 JUNCTION AND PULL BOXES

A. Pull boxes and junction boxes shall be provided to facilitate the installation of cable and wires. "Condulet" type fittings shall not be used in lieu of boxes when the conduit contains wire #4 AWG or larger.

B. Installation:

1. Install boxes as required to facilitate cable installation in raceway systems.

2. Generally provide boxes in conduit runs of more than 100 feet.

3. Locate boxes strategically and make them of such shape and size to permit easy pulling of wire or cables. Size boxes in accordance to NEC Article 314.28 requirements.

C. Covers:

1. Provide boxes so that covers are readily accessible and easily removable after completion of the installation.

2. Include suitable access doors for boxes above suspended ceilings.

3. Select a practical size for each box and cover.

END OF SECTION 16130

SECTION 16140

WIRING DEVICES

PART 1- GENERAL

1.01 WORK INCLUDED

A. Furnish and install complete lighting and receptacle systems, including lighting fixtures, receptacles, switches, and all accessories and appurtenances as shown on the drawings and as specified herein.

1.02 SUBMITTALS

A. Submit shop drawings showing complete construction details for all equipment in compliance with Division 1 - General Provisions.

B. Submittal shall be clearly marked showing only equipment provided. Mark through equipment option not provided.

C. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

D. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.

1.03 QUALITY ASSURANCE

A. Wiring Devices shall be in compliance with the National Electrical Code, and shall be constructed in compliance with the Underwriters' Laboratories and shall be Underwriters' Laboratories labeled.

PART 2- PRODUCTS

2.01 MATERIALS

A. Switches:

1. Wall switches shall be of the heavy-duty specification grade, toggle action, and flush mounting quiet type.

2. Wall switches shall be of the following types and manufacturer, or equal.

a. Single Pole: Arrow-Hart, Catalog No. 1991I, or Pass and Seymour 20AC1-I, or Leviton 1221-2I.

b. Double Pole: Arrow-Hart, Catalog No. 1992I, or Pass and Seymour 20AC2-I, or Leviton 1222-2I.

c. Three-Way: Arrow-Hart, Catalog No. 1993I, or Pass and Seymour 20AC3-I, or Leviton 1223-2I.

d. Momentary Contact, 2 Circuit, Center Off: Arrow-Hart, Catalog No. 1895I, or Pass and Seymour 1250-I, or Leviton 1256-I.

e. Weatherproof switch covers shall be Crouse-Hinds rain-tight Type DS with PVC coating where used with aluminum.

f. Lock out attachment when used for instrument disconnect shall be NEMA 4X.

3. Switch to be installed in classified area shall be rated for application per NEC 500.

B. Receptacles:

1. Wall receptacles shall be 120 volts, single-phase, single or duplex, industrial specification hospital grade, and be of the following types:

a. Duplex, 20A, 125V, 2P, 3W: Arrow-Hart, Catalog No. 8300I, or Pass and Seymour 9300-HG, or Leviton 8300-I.

b. Ground fault interrupter, lockout type, duplex, 20A, 125V, 2P, 3W: Leviton 7899I.

c. Stainless steel indoor mounting plate for GFCI receptacle: Arrow-Hart, Catalog No. S2G, or Pass and Seymour S-26N, or Leviton 84401-40.

d. Weatherproof cover for GFCI receptacle in FS box while in use: Leviton 5997 GY.

e. Computer or computer related equipment: Leviton 8380IG, or Pass and Seymour, Catalog No. IG6362ISP, ivory with translucent surge suppressor, 5-20R, 20A, 125V duplex hospital grade with audible alarm.

2. Receptacles listed as weatherproof shall be provided with a watertight back box and hinged cover.

3. Receptacles to be installed in classified area shall be rated for the application per NEC 500.

C. Safety Switches

1. Safety Switches shall be of heavy duty, specification grade.

2. Switch shall be UL listed.

3. Switch shall be NEMA 4X 316ss when located outdoor.

4. Switch shall be equipped with auxiliary contacts that open when the switch is placed in the “Open” position.

5. Switch located in classified area shall be rated for the application per NEC 500.

6. Switch shall be quick-make, quick-break construction.

7. Operating handle shall be of box mounted type that directly drives the switch mechanism suitable for padlocking in the off position with up to three padlocks. Switch shall be interlock defeat.

8. The interior shall be easily removable. The wiring gutter shall be clear of any obstructions and moving parts.

9. Fusible switch, fuse selection shall be rated for the application, minimum KAIC rating shall match the protective device on the line side of the switch.

10. Switch shall be provided with grounding kit.

11. Provide service entrance rated fuse disconnect switch when switch is loacated on the line or load side of the utility meter.

PART 3- EXECUTION

3.01 INSTALLATION

A. Wiring devices must be operating properly at final completion.

B. Provide hangers and support members for wiring devices as required for proper installation.

C. Provide appurtenances which include stud supports, stems, mounting brackets, frames, and plaster rings.

D. Support wiring devices from the building structure, or from furring channels. Furring channels must be a minimum of 1-1/2 inches wide.

3.02 RECEPTACLE AND SWITCH INSTALLATION

A. Mounting Heights(from the bottom of the device):

1. Mount outdoor receptacles at least 24 inches above finished grade.

2. Mount safety switches 2’ - 6” above finished slab or grade to bottom of switch unless otherwise noted. Maximum height of operating handle shall not exceed 5’ - 6”.

3. Mount all wall switches 54 inches above finished floor.

4. Mount thermostats 60 inches above floor.

B. Boxes:

1. Finished areas such as offices: Flush mounted devices in aluminum boxes.

2. Other areas: Surface mounted cast aluminum metal boxes.

C. Weatherproof Receptacle Lift Covers: Install with hinge pin horizontal at top of the finished plate. Provide oversized covers for plug-in devices.

D. Install receptacles with grounded blade up.

E. Switches and receptacles shall be mounted in 4” x 4” aluminum outlet boxes concealed in the office walls.

F. Indoor and outdoor boxes shall be grounded by use of a No. 12 green insulated ground wire run with the wiring per Division 16 specification.

END OF SECTION 16140

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SECTION 16231

PACKAGE GENERATOR SET

PART 1- GENERAL

1.01 REFERENCES AND STANDARDS

A. The generator set covered by these specifications shall be designed, tested, rated, assembled and installed in strict accordance with all applicable standards below:

1. FCC Part 15 Subpart B
2. ISO8528
3. IEC61000
4. UL508
5. UL2200
6. UL142
7. Designed to allow for installed compliance to NFPA 70, NFPA99 and NFPA 110

1.02 WORK INCLUDED

A. Installation

1. The work includes supplying and installing a complete integrated generator system. The system consists of a natural gas generator set with related component accessories.
2. Contractor shall obtain a Fire Marshal's permit for the generator installation and shall include in the Bid Proposal.

B. Fuel System

1. The CONTRACTOR shall provide the piping of the natural gas to the generator.

C. System Test

1. A complete system load test shall be performed after all equipment is installed. Guidelines in the Start-up Section.

D. Requirements, Codes and Regulations

1. The equipment supplied and installed shall meet the requirements of the NEC and all applicable local codes and regulations. All equipment shall be of new and current production by a MANUFACTURER who has 15 years of experience building this type of equipment. Manufacturer shall be ISO9001 certified.

1.03 APPROVED MANUFACTURER

A. Caterpillar

B. Cummins power generation

C. Generac

D. Kohler

1.04 SUBMITTALS

A. Engine-generator submittals shall include the following information:

1. Factory published specification sheet.

2. Manufacturer's catalog cut sheets of all auxiliary components such as battery charger, control panel, enclosure, etc.

3. Dimensional elevation and layout drawings of the generator set, enclosure and transfer switchgear and related accessories.

4. Weights of all equipment.

5. Concrete pad recommendation, layout and stub-up locations of electrical and fuel systems.

6. Interconnect wiring diagram of complete emergency system, including generator, switchgear, day tank, remote pumps, battery charger, control panel, and remote alarm indications.

7. Engine mechanical data, including heat rejection, exhaust gas flows, combustion air and ventilation air flows, fuel consumption, etc.

8. Generator electrical data including temperature and insulation data, cooling requirements, excitation ratings, voltage regulation, voltage regulator, efficiencies, waveform distortion and telephone influence factor.

9. Generator resistances, reactance and time constants.

10. Generator locked rotor motor starting curves.

11. Manufacturer's and dealer's written warranty.

12. Sound attenuated enclosure.

1.05 SYSTEM RESPONSIBILITY

A. Generator Set Distributor

1. The completed engine generator set shall be supplied by the Manufacturer's authorized distributor only.

2. The automatic transfer switch specified in section 16496 shall be supplied by the generator set manufacturer in order to establish and maintain a single source of system responsibility and coordination.

B. Requirements, Codes and Regulations

1. The equipment supplied and installed shall meet the requirements of NEC and all-applicable local codes and regulations. All equipment shall be new, of current production. There shall be one

source responsibility for warranty; parts and service through a local representative with factory trained service personnel.

1.06 WARRANTY

A. Two Year Standby (ISO 8528-1: ESP) Generator Set Warranty

1. The manufacturer's standard warranty shall in no event be for a period of less than two (2) years from date of acceptance testing of the system and shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Running hours shall be limited to 500 hours annually for the system warranty by both the manufacturer and servicing distributor. Submittals received without written warranties as specified will be rejected in their entirety.

1.07 PARTS AND SERVICE QUALIFICATIONS

A. Service Facility

1. The engine-generator supplier shall maintain 24-hour parts and service capability within 100 miles of the project site. The distributor shall stock parts as needed to support the generator set package for this specific project. The supplier must carry sufficient inventory to cover no less than 80% parts service within 24hrs and 95% within 48 hours.

B. Service Personnel

1. The dealer shall maintain qualified factory trained service personnel.

PART 2- PRODUCT SPECIFICATIONS

2.01 GENERAL REQUIREMENTS

A. Genset Requirements

1. The generator set shall be Standby Duty rated at the minimum 60.0 kW, 1800 RPM, 0.8 power factor, 480 V, 3-Phase, 60 hertz, including radiator fan and all parasitic loads. Generator set shall be sized to operate at the specified load at a maximum ambient of 110°F and altitude of 3000.0 feet maximum.

a. Emergency Standby Power (ESP) as defined by the following:

b. Typical Load Factor = 70% of ESP rating with variable load

c. Typical Hours per Year = 50 hours

d. Maximum Expected Usage = 200 hours/year

e. Standby Rating as defined by the following:

f. Typical Load Factor = 70% of standby power rating with variable load

g. Typical Hours per Year = 200 hours

h. Maximum Expected Usage = 500 hours/year

2. Generator load shall include all load on panel EP1, for purpose of sizing the generator transformers shall be 100% loaded.

B. Material and Parts

1. All materials and parts comprising the unit shall be new and unused.

C. Engine

1. The engine shall be natural gas fueled, four (4) cycle 6 cylinder, water-cooled, while operating with nominal speed not exceeding 1800 RPM. The engine will utilize in-cylinder combustion technology, as required, to meet applicable EPA non-road mobile regulations and/or the EPA NSPS rule for stationary reciprocating compression ignition engines. Additionally, the engine shall comply with the State Emission regulations at the time of installation/commissioning. Actual engine emissions values must be in compliance with applicable EPA emissions standards per ISO 8178 – D2 Emissions Cycle at specified ekW / bHP rating. Utilization of the "Transition Program for Equipment Manufacturers" (also known as "Flex Credits") to achieve EPA certification is not acceptable. The in-cylinder engine technology must not permit unfiltered exhaust gas to be introduced into the combustion cylinder. Emissions requirements / certifications of this package: NSPS for STATIONARY SI ICE

D. Engine Governing

1. The engine governor shall be an electronic Engine Control Module woodward flo tech control with 24-volt DC Electric Actuator. Speed shall be sensed by a magnetic pickup off the engine flywheel ring gear. A provision for remote speed adjustment shall be included. The ignition system will be digital control. In the event of a DC power loss, the forward acting actuator will move to the minimum fuel position.

2.02 GENERATOR

A. Generator Specifications

1. The synchronous three phase generator shall be a single bearing, self-ventilated, drip-proof design in accordance with NEMA MG 1 and directly connected to the engine flywheel housing with a flex coupling. The generator shall meet performance class G3 of IEC. The excitation system shall enable the alternator to sustain 300% of rated current for ten seconds during a fault condition and shall improve the immunity of the voltage regulator to non-linear distorting loads. The excitation system shall be of brushless construction and be independent of main stator windings (either permanent magnet or auxiliary windings).

B. Voltage Regulator

1. The digital voltage regulator shall be microprocessor based with fully programmable operating and protection characteristics. The regulator shall maintain generator output voltage within +/- 0.25% for any constant load between no load and full load. The regulator shall be capable of sensing true RMS in three phases of alternator output voltage, or operating in single phase sensing mode. The voltage regulator shall include a VAR/Pf control feature as standard. The regulator shall provide an adjustable dual slope regulation characteristic in order to optimize voltage and frequency response for site conditions. The voltage regulator shall include standard the capability to provide generator paralleling with reactive droop compensation and reactive differential compensation.

2. The voltage regulator shall be microprocessor based with fully programmable operating and protection characteristics. The regulator shall maintain generator output voltage within +/- 0.25% for any constant load between no load and full load. The regulator shall be capable of sensing true RMS in three phases of alternator output voltage, or operating in single phase sensing mode, The voltage regulator shall include a VAR/Pf control feature as standard. The regulator shall include standard the capability to provide generator paralleling with reactive droop compensation and reactive differential compensation.

C. Motor Starting

1. Provide locked rotor motor starting capability to handle the load at 20% instantaneous voltage dip as defined per NEMA MG 1. Sustained voltage dip data is not acceptable.

2.03 CIRCUIT BREAKER

A. Circuit Breaker Specifications

1. Provide a generator mounted 100% circuit breaker, molded case, Qty.(1) 200 amp trip, 3 pole, NEMA. Breaker shall utilize a solid state trip unit. The breaker shall be Listed and connected to engine/generator safety shutdowns. Breaker shall be housed in an extension terminal box which is isolated from vibrations induced by the generator set. Mechanical type lugs, sized for the circuit breaker feeders shown on drawing, shall be supplied on the load side of breaker.

2.04 CONTROLS – GENERATOR SET MOUNTED

A. Provide a fully solid-state, microprocessor based, generator set control. The control panel shall be designed and built by the engine manufacturer. The control shall provide all operating, monitoring, and control functions for the generator set.

B. Environmental

1. The generator set control shall be tested and certified to the following environmental conditions.

a. –40°C to +70°C Operating Range

b. 95% humidity non-condensing, 30°C to 60°C

c. IP22 protection

d. 5% salt spray, 48 hours, +38°C, 36.8V system voltage

e. Sinusoidal vibration 4.3G's RMS, 24-1000Hz

f. Electromagnetic Capability (89/336/EEC, 91/368/EEC, 93/44/EEC, 93/68/EEC, BS EN 50081-2, 50082-2)

g. Shock: withstand 15G

C. Functional Requirements

1. The following functionality shall be integral to the control panel.

a. The control shall include a 33 x 132 pixel, 24mm x 95mm, positive image, transflective LCD display with text based alarm/event descriptions.

b. Audible horn for alarm and shutdown with horn silence switch

c. Standard ISO labeling

d. Multiple language capability

e. Remote start/stop control

f. Local run/off/auto control integral to system microprocessor

g. Cooldown timer

h. Speed adjust

i. Lamp test

j. Push button emergency stop button

k. Voltage adjust

l. Voltage regulator V/Hz slope - adjustable

m. Password protected system programming

D. Digital Monitoring Capability

1. The controls shall provide the following digital readouts for the engine and generator. All readings shall be indicated English units

a. Engine

(i) Engine oil pressure

(ii) Engine oil temperature

(iii) Engine coolant temperature

(iv) Engine RPM

(v) Battery volts

b. Generator

(i) Generator AC volts (Line to Line, Line to Neutral and Average)

(ii) Generator AC current (Avg and Per Phase)

(iii) Generator AC Frequency

(iv) Generator kW (Total and Per Phase)

(v) Generator kVA (Total and Per Phase)

(vi) Generator kVAR (Total and Per Phase)

(vii) Power Factor (Avg and Per Phase)

(viii) Total kW-hr

(ix) Total kVAR-hr

(x) % kW

(xi) % kVA

(xii) % kVAR

c. Voltage Regulation

(i) Excitation voltage

(ii) Excitation current

E. Alarms and Shutdowns

1. The control shall monitor and provide alarm indication and subsequent shutdown for the following conditions. All alarms and shutdowns are accompanied by a time, date, and engine hour stamp that are stored by the control panel for first and last occurrence:

a. Engine Alarm/Shutdown

(i) Low oil pressure alarm/shutdown

(ii) High coolant temperature alarm/shutdown

(iii) Loss of coolant shutdown

(iv) Overspeed shutdown

(v) Overcrank shutdown

(vi) Low coolant level alarm

(vii) Low fuel level alarm

(viii) Emergency stop depressed shutdown

(ix) Low coolant temperature alarm

(x) Low battery voltage alarm

(xi) High battery voltage alarm

(xii) Control switch not in auto position alarm

(xiii) Battery charger failure alarm

b. Generator Alarm/Shutdown

(i) Generator Over Voltage

(ii) Generator Under Voltage

(iii) Generator Over Frequency

(iv) Generator Under Frequency

(v) Generator Reverse Power

(vi) Generator Overcurrent

c. Voltage Regulation

(i) Loss of excitation alarm/shutdown

(ii) Instantaneous over excitation alarm/shutdown

(iii) Time over excitation alarm/shutdown

(iv) Rotating diode failure

(v) Loss of sensing

(vi) Loss of PMG

F. Maintenance

1. All engine, voltage regulator, control panel and accessory units shall be accessible through a single electronic service tool. The following maintenance functionality shall be integral to the generator set control:

a. Engine running hours display

b. Service maintenance interval (running hours or calendar days)

c. Engine crank attempt counter

d. Engine successful starts counter

e. 20 events are stored in control panel memory

f. Programmable cycle timer that starts and runs the generator for a predetermined time. The timer shall use 14 user-programmable sequences that are repeated in a 7-day cycle. Each sequence shall have the following programmable set points:

(i) Day of week

(ii) Time of day to start

(iii) Duration of cycle

G. Remote Communications

1. Remote Communications

a. The control shall include Ethernet TCPIP via CAT 6 network cable.

H. Remote Monitoring Software

1. The control shall provide Monitoring Software with the following functionality

    a. Provide access to all date and events on generator set communications network

    b. Provide remote control capability for the generator set

    c. Ability to communicate Ethernet TCPIP.

I. Local Annunciation

1. Local Annunciator (NFPA 99/110, CSA 282)

    a. Provide a local, control panel mounted, annunciator to meet the requirements of NFPA 110, Level 1.

        (i) Annunciators shall be networked directly to the generator set control

        (ii) Local Annunciator shall include a lamp test pushbutton, alarm horn and alarm acknowledge pushbutton

        (iii) Provide the following individual light indications for protection and diagnostics

            (a) Overcrank

            (b) Low coolant temperature

            (c) High coolant temperature warning

            (d) High coolant temperature shutdown

            (e) Low oil pressure warning

            (f) Low oil pressure shutdown

            (g) Overspeed

            (h) Low coolant level

            (i) EPS supplying load

            (j) Control switch not in auto

            (k) High battery voltage

            (l) Low battery voltage

            (m) Battery charger AC failure

            (n) Emergency stop

2.05 COOLING SYSTEM

A. The generator set shall be equipped with a rail-mounted, engine-driven radiator with blower fan and all accessories. The cooling system shall be sized to operate at full load conditions and 110° F ambient air entering the enclosure. The generator set supplier is responsible for providing a properly sized cooling system based on the enclosure static pressure restriction.

2.06 FUEL SYSTEM

A. The fuel system shall be integral with the engine. In addition to the standard system provide low

B. Pressure fuel system, gas pressure regulator and energize to run ETR gas shut off valve.

2.07 SILENCER

A. A critical grade silencer, companion flanges, and flexible stainless steel exhaust fitting properly sized shall be furnished and installed according to the manufacturer's recommendation. The contractor shall install as shown on the enclosure drawing.

2.08 STARTING SYSTEM

A. Starting Motor

1. A DC electric starting system with positive engagement shall be furnished. The motor voltage shall be as recommended by the engine manufacturer.

B. Jacket Water Heater

1. Jacket water heater shall be provided and shall be sized to insure that genset will start within the specified time period and ambient conditions.

C. Batteries

1. Batteries - A lead-acid storage battery set of the heavy-duty diesel starting type shall be provided. Battery voltage shall be compatible with the starting system.

D. Battery Charger

1. A UL listed 10 amp voltage regulated battery charger shall be provided for the engine-generator set. Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float and equalize charge settings, with provisions to automatically switch between the two modes. It shall maintain its rated output voltage within ±0.2% with AC input variation of ±10%. Operational monitors shall provide with individual form C contacts rated at 4 amps, 120 VAC, 30VDC for remote indication of battery charger malfunction, low battery voltage, and high battery voltage. Charger shall include an Analog DC voltmeter and ammeter and fused AC input and DC output, and shall be wall mount type in a NEMA 1 enclosure.

2.09 ENCLOSURE

A. Sound Attenuated Weatherproof Enclosure

1. The complete diesel engine generator set, including generator control panel, engine starting batteries, battery charger, generator, circuit breaker, control panel, annunciator, and fuel oil tank, shall be enclosed in a factory assembled, weather protective enclosure mounted on the fuel tank base.

a. A weather resistant enclosure of steel with electrostatically applied powder coated baked polyester paint. It shall consist of a roof, side walls, and end walls. Fasteners shall be either zinc plated or stainless steel. Handles shall be key lockable, all doors keyed alike, and hinges shall be zinc die cast or stainless steel. Access doors shall be hinged and can be lifted off

after opening 90 degrees. Intake openings shall be screened to prevent the entrance of rodents or pests.

b. Lube oil and coolant drains shall be extended to the exterior of the enclosure and terminated with drain valves. Cooling fan and charging alternator shall be fully guarded to prevent injury.

c. The enclosures resulting sound level shall not exceed 78 dbA at 23 feet.

PART 3- EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's recommendations, the project drawings and specifications, and all applicable codes.

3.02 START-UP AND TESTING

A. Coordinate all start-up and testing activities with the Engineer and Owner. After installation is complete and normal power is available, the manufacturer's local dealer shall perform the following:

B. Perform a 2 hour load bank test at a 1.0 PF at full nameplate rating. Loadbank, cables and other equipment required for this test to be supplied by the genset supplier.

3.03 OPERATION AND MAINTENANCE MANUALS

A. Provide operation and maintenance manuals covering the generator, and auxiliary components. Include final as-built wiring interconnect diagrams and recommended preventative maintenance schedules.

B. Operation and maintenance manual shall be supplied in accordance with Section 01730.

3.04 TRAINING

A. On-Site Training

1. Provide on-site training to instruct the owner's personnel in the proper operation and maintenance of the equipment. Review operation and maintenance manuals, parts manuals, and emergency service procedures.

END OF SECTION 16231

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SECTION 16289

SURGE PROTECTIVE DEVICES

PART 1- GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes surge protective devices for low-voltage power, control, and communication equipment.

1.03 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. SVR: Suppressed Voltage Rating.

C. SPD: Surge Protective Device

1.04 SUBMITTALS

A. Product Data: For each type of product indicated, include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.

B. Product Certificates: For surge protective devices, signed by product manufacturer certifying compliance with the following standards:

1. UL 1283 - Electromagnetic.

2. UL 1449 3rd Edition – UL Standard for Surge Protective Devices.

C. Qualification Data: For testing agency.

D. Field quality-control test reports, including the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Failed test results and corrective action taken to achieve requirements.

E. Operation and Maintenance Data: For transient voltage suppression devices to include in emergency, operation, and maintenance manuals.

F. Warranties: Special warranties specified in this Section.

G. Submittal shall be clearly marked showing only equipment provided. Mark through equipment option not provided.

H. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.

I. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain surge protective devices and accessories through one source from a single manufacturer.

B. Product Options: Drawings indicate size, dimensional requirements, and electrical performance of suppressors and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage (1000 Volts or less) AC Power Circuits."

E. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices."

F. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Standard for Surge Protective Devices."

1.06 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Engineer not less than two days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Engineer’s written permission.

B. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.

2. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).

3. Humidity: 0 to 85 percent, non-condensing.

4. Altitude: Less than 20,000 feet (6090 m) above sea level.

1.07 COORDINATION

A. Coordinate location of field-mounted surge protective devices to allow adequate clearances for maintenance.

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within two (2) years from date of Substantial Completion.

PART 2- PRODUCTS

2.01 MANUFACTURERS

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Phoenix Contact

    a. Incoming Line: Model #5603030

    b. SCADA Panel and Pump Control Panel: Model # 2856702

2. Engineer Approved Equal

2.02 480V SWITCHBOARD AND 480V MCC SUPPRESSORS

A. Surge Protective Devices with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.

2. Fabrication using bolted compression lugs for internal wiring.

3. Integral disconnect switch.

4. Redundant suppression circuits.

5. Redundant or replaceable modules.

6. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.

7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.

8. LED indicator lights for power and protection status.

9. Audible alarm, with silencing switch, to indicate when protection has failed.

10. One set of dry contacts, for remote monitoring of protection status. Coordinate with building power monitoring and control system.

11. Surge-event operations counter.

B. Surge suppressor shall be of type 2.

C. Peak Single-Impulse Surge Current Rating: 300kA/phase.

D. Connection Means: Permanently wired.

E. Protection modes and UL 1449 SVR for grounded wye circuits with voltages of 480Y/277, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 1200V
2. Line to Ground: 1000V
3. Neutral to Ground: 1000V

F. Protection modes and UL 1449 SVR for voltages of 480, 3-phase, 3-wire, delta circuits shall be as follows:

1. Line to Line: 3000V
2. Line to Ground: 1500V

2.03 PANELBOARD SUPPRESSORS

A. TVSS with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits.
5. Redundant replaceable modules.
6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
7. LED indicator lights for power and protection status.
8. Audible alarm, with silencing switch, to indicate when protection has failed.
9. One set of dry contacts rated at 5 A and 250Vac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
10. Surge-event operations counter.

B. Peak Single-Impulse Surge Current Rating: 120 kA/ phase

C. Protection modes and UL 1449 SVR for grounded wye circuits with voltages of 480Y/277, 208Y/120, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 800 V for 480Y/277.
2. Line to Ground: 800 V for 480Y/277.

3. Neutral to Ground: 800 V for 480Y/277.

2.04 ENCLOSURES

A. Install surge protective devices in the same cabinet as the MCC, switchboard, and 480V panelboard.

PART 3- EXECUTION

3.01 INSTALLATION OF SURGE PROTECTION DEVICES

A. Surge protective devices shall be installed by the panelboard manufacturer at the factory.

3.02 PLACING SYSTEM INTO SERVICE

A. Do not energize or connect service entrance equipment, panelboards, control terminals, data terminals to their sources until surge protection devices are installed and connected.

3.03 FIELD QUALITY CONTROL

A. Remove and replace malfunctioning units and retest.

3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transient voltage suppression devices.

END OF SECTION 16289

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SECTION 16360

UNDERGROUND DUCT BANKS

PART 1- GENERAL

1.01 WORK INCLUDED

A. Provide underground electrical duct banks as shown on the Drawings.

1.02 REFERENCE STANDARDS

A. The following standards shall apply as if written here in their entirety:

1. ANSI C80.1, Specifications for Zinc-Coated Rigid Steel Conduit.
2. ANSI/ACI 301, Specifications for Structural Concrete for Buildings.
3. ANSI/ASTM A 615, Specifications for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
4. ANSI/NEMA TC6, PVC and ABS Plastic Utilities Duct for Underground Installation.
5. ANSI/NEMA TC9, Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation.

PART 2- PRODUCTS

2.01 DUCTS AND FITTINGS

A. Unless otherwise noted, provide Schedule 40 PVC conduit encased in concrete. Provide fittings of the same type material as the conduit.

2.02 CONDUIT AND FITTINGS

A. Provide PVC conduit to PVC coated aluminum adapter fitting in order to convert to metal conduit before surfacing from the underground duct bank.

B. Expansion/deflection fillings to be installed on all stub-up above grade from duct banks.

2.03 CONCRETE

A. Provide concrete conforming to the following.

1. Compressive strength: 4,000 psi at 28 days.
2. Slump: Not exceeding six inches.
3. Aggregate size: Use pea gravel.
4. Additive: Red ferrous oxide concrete coloring pigment mixed at the rate of 1-1/2 pounds per sack of cement. Sprinkle color on the top of the duct bank will be unacceptable.

2.04 REINFORCING BARS

A. Provide Grade 40 steel reinforcing bars, for all duct banks.

PART 3- EXECUTION

3.01 CONSTRUCTION

A. Duct bank configurations are detailed on the drawings. A minimum of 3-inch concrete cover shall be required on all sides of the conduits. Conduits shall be spaced with 3-inch clearance on all sides.

3.02 LOCATION AND INSPECTION

A. Before beginning trenching operations stake out the proposed duct bank routing and obtain approval of the Owner. After trenching has begun and before any ducts or conduits are placed, notify the Owner so that the trenching and installation may be inspected. Also notify the Owner prior to any placement of concrete for duct banks, so that he may observe the placing. Placing concrete on muddy trench bottoms will not be acceptable.

3.03 EXCAVATION AND BACKFILL

A. Excavation: Excavate trenches for installation of duct banks. Form the trench bottom to follow closely the specified grade and depth for the duct banks.

B. Backfill: Trenches may be backfilled with excavated soil and supplemented as necessary with select materials. Compact the backfill and mound slightly above natural grade.

C. Restoration: Restore adjacent areas disturbed by trenching or backfilling to a condition equal to the original.

3.04 PLACING OF DUCT BANKS

A. Cover: Unless otherwise shown, provide a minimum 18” of earth and select materials cover. Coordinate grade with other work, if in conflict, rework grade at no cost to Owner.

B. Grade: Place duct banks with a minimum grade of four inches per 100 feet. Grade between manholes may be from one manhole to the next manhole or from a high point between manholes. Where terminating ducts inside of buildings, always slope the grade away from building to the nearest manhole.

C. Changes in Direction: Make changes in direction of runs exceeding a total of 10 degrees, either horizontal or vertical, by using long sweep bends. Long sweep bends must have a minimum radius of curvature of 3 feet and may be made up of one or more curved or straight sections. Manufactured bends having a minimum radius of curvature of three feet may be used at the ends of duct runs which are less than 100 feet in length.

D. Joints: Make joints in ducts and conduits watertight, in accordance with manufacturers recommendations. Stagger joints in adjacent ducts and conduits a minimum of six inches. Make joints between ducts and conduit with appropriate no-thread-to-threaded adapters. Use appropriate sealant.

E. Spacing: Unless otherwise shown, space ducts and conduits with 3” spacers. Place spacers or separators on not greater than five-foot centers. Use spacers or separators made of plastic, concrete or a suitable nonmetallic, nondecaying material.

F. Drainage: All conduit duct banks shall be sloped sufficiently to drain into manholes, pull boxes or sumps.

3.05 PLACING OF CONCRETE

A. Place concrete using chutes and tremies as necessary to limit the free drop of the mix to a maximum of two feet. Carefully rod or vibrate the concrete to aid uniform encasement of the ducts. Smooth the top of the pour with a float. Encase the conduits in concrete, a minimum thickness of three inches, on all sides.

3.06 CLEANING

A. Thoroughly clean all ducts and conduits before placing. During construction and after the duct line is completed, plug open ends of ducts and conduits to prevent the entrance of foreign matter. After the duct line has been completed, pull a flexible mandrel through each duct and conduit. The mandrel must not be less than 12 inches long with a diameter approximately 1/4 inch less than the inside diameter of the duct or conduit. After cleaning, place in each duct and conduit a No. 30 nylon line with a plastic tag on each end reading "Pulling Line", and a tag identifying the location of the other end.

3.07 SPECIAL PROJECT REQUIREMENTS

A. Contractor shall employ hand trenching at locations where existing underground utilities are present.

B. All damaged utilities should be repaired immediately in manner acceptable to the Owner at Contractor's expense. Any damaged cables shall be replaced in full. Splices shall not be acceptable. Damaged conduits shall be replaced between the two closest manholes and cables repulled.

C. Install a #3/0 bare copper grounding conductor, centered over the ductbank and located 3" above the ductbank in the backfill. Bond ductbank grounding conductor to building or transformer ground loop at one end and to the manhole ground electrode at the other end.

END OF SECTION 16360

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SECTION 16373

STAND ALONE LOW VOLTAGE SOLID STATE STARTERS

PART 1- GENERAL

1.01 SCOPE OF SUPPLY

A. Furnish and install solid state starter(s) as shown on the drawings and as specified herein, including all required appurtenances. The solid-state starter(s) shall be microprocessor controlled, suitable for use with three phase induction motors rated 480 VAC or less. The starter(s) shall provide a smooth, stepless motor acceleration and deceleration.

1.02 QUALITY ASSURANCE

A. The solid-state starters shall be the product of a manufacturer who has produced solid state starters of the same type and size for a minimum of 10 years.

B. The solid state starter shall be designed, manufactured and tested to conform, where applicable to the following industry standards.

1. NEC
2. UL
3. EEMAC
4. IEEE
5. NEMA ICS2
6. OSHA

C. Environmental Requirements:

1. Temperature: 32^{o}F to 122^{o}F
2. Relative Humidity: up to 95%, non-condensing
3. Input Power: 480 VAC, 3 Phase, 60 Hz

1.03 SUBMITTALS

A. Submittals shall be furnished in accordance with Division 1.

B. Provide the following:

1. Elementary wiring and interconnection diagrams in accordance with NEMA standards.
2. Size, type, and rating of all system components.
3. Enclosure frontal elevation and dimension drawings.
4. Internal component layout diagrams.

5. Available conduit entry and exit locations.

6. Manufacturer's product data sheets.

C. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.

D. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

1.04 DELIVERY, STORAGE AND HANDLING

A. Handling and shipment of the equipment shall be in such a manner to prevent internal component damage, breakage, denting and scoring of the enclosure finish

B. Equipment shall be stored indoors in a clean, dry environment. Energize space heaters if furnished.

PART 2- PRODUCTS

2.01 MANUFACTURERS

A. Benshaw

B. Or Engineer approved equal.

2.02 EQUIPMENT DESIGN CRITERIA

At a minimum, the Starter(s) shall meet the following criteria:

A.	Size:	As shown on the Contract Drawings
B.	Minimum Overload Rating:	500% of Starter FLA for 60 Seconds, 125% Continuous
C.	PIV Rating:	1600V
D.	Rated Short Circuit Amps:	42KAIC
E.	Overall Efficiency w/o bypass	99.7 %
F.	Overall Efficiency w/bypass	99.97%
G.	SCR Firing Design:	individual phase transformer coupling
H.	Transient Voltage Protection:	Rc snubber networks on each phase Assembly
I.	Control Input:	120 VAC

2.03 ENCLOSURE CONSTRUCTION

A. Construct to comply with NEMA Part ICS 2.

B. Basic structure shall be welded type construction utilizing minimum of 11 GA sheet metal.

1. Doors shall be minimum 11 GA sheet metal.

2. Door latches and hinges capable of holding door closed during maximum fault condition.

3. Provide door interlocks to prevent doors from being opened with power applied.

C. The Starters and any required accessories, or auxiliary items, shall fit within the space shown on the Plans. Any costs associated with furnishing equipment which exceeds the available space shall be borne by the Contractor.

D. Finish:

1. Primer shall be recoatable epoxy primer

2. Color shall be ANSI 61

E. Complete with internal power and control wires including terminations for external connections. Phase sequencing shall have proper identification and control wires shall have suitable markings at terminations.

2.04 BYPASS CONTACTORS

A. Bypass contactor shall be provided

1. Full HP rated

2. Current rating: manufacturer standard for horsepower rating.

3. Voltage rating: Up to 480 VAC

4. The bypass contactor shall be sequenced by the Starter manufacturer for proper operation of the solid-state starter

5. The bypass contactor shall bypass the SCRs after reaching full voltage and while the starter is in the "Run" mode.

6. Rated for 42KAIC.

2.05 CONSTRUCTION

A. Enclosure Construction:

1. Soft start shall be incorporated into the pump control panel

a. HP rated bypass contactor

b. Low voltage control devices

c. Auxiliary control devices as specified or shown on the Contract Drawings.

B. SCR Stacks:

1. Arranged vertically for proper heat dissipation.

2. Heat sinks sized to allow for required Starts per Hour without requiring auxiliary cabinet cooling fans.

2.06 CONTROL DEVICES

A. Control Power Transformer

1. Provide an appropriately rated internal 480-120 transformer

2. Supply two fuses on the primary and one fuse on secondary side.

B. Control Wiring to be minimum 14 AWG stranded.

C. Terminal Strips: Rated for 600V, suitable for termination of up to 10 AWG wire.

D. Pushbuttons, pilot lights, and control relays to be heavy duty rated to 600V.

2.07 SOLID STATE STARTER LOGIC CONTROL

A. Starter shall be fully microprocessor controlled and operated. At a minimum the logic control shall include the following:

1. The Starter(s) shall be complete with the following standard features and adjustments

a. Motor and Load Protection shall be integral to the starter assembly. Motor protection shall be based upon modeling of the thermal characteristics of the motor as programmed. All current referenced protection shall be calculated from the motor nameplate FLA, and automatically adjust for the Service Factor, NEMA Design, Insulation Class, Line Voltage and Line Frequency as entered at time of commissioning.

b. Thermal Overload shall be provided by the on-board microprocessor control. The overload trip curve classes shall be programmed from between Class 5 and Class 30. The overload protection shall be based on a Dynamic Thermal Register retained in memory and shall include the following:

(i) Retentive Thermal Memory. To be used to ensure that Dynamic Thermal Register does not lose motor temperature data after power loss.

(ii) Dynamic Reset Capacity. Shall retain a snapshot of the thermal capacity necessary to restart the motor.

(iii) True Thermal Modeling. Shall be a feature of the overload and reset calculations.

c. Separate Start & Run overload trip curves.

d. Overload Alarm.

2. Provide a door mounted Operator Interface Panel with the following functionality:

a. Backlit LCD- 2 lines, 20 Characters

b. Password Protection with 3 levels

c. EEPROM memory for Starter Parameters and Diagnostics

d. Status Indication via LCD display and LEDs

e. Scrolling Menu/Parameters

f. Metering Mode Display

g. Windows based Commissioning/Monitoring Software

B. Provide a Windows based software package with the Solid State Starter(s) included under this contract for use on an Owner furnished PC. The software shall be utilized to program and monitor the starter parameters listed in paragraphs C-H. This software shall include the following features and functions:

1. Connect to starters via RS-485 port
2. Provide realtime starter basic parameter feedback
3. Provide realtime Start and Stop capabilities
4. Provide capability for full Starter parameter programming
5. Provide an Event Recorder Display
6. Communication speed up to 9600 baud

C. Programmable Motor Control Functions

1. Shall be as shown on contract drawing.

2.08 MOTOR PROTECTION

Provide motor monitoring and protection features as described below shall include as a minimum below in addition to requirements in equipment specifications and on contract drawings.

A. The following ANSI relaying device functions shall be provided:

1. #27-Under voltage
2. #37-Under current
3. #46-Phase Reversal
4. #47-Phase Sequence
5. #49-I2T Thermal Motor Overload
6. #50-Instantaneous overcurrent relay
7. #51-Time Overcurrent
8. #55-Power Factor
9. #59-Overvoltage
10. #66-Starts Per Hour
11. #81-Frequency
12. #86-Lockout/Start Inhibit

PART 3- EXECUTION

3.01 TESTING

A. All incoming material shall be inspected and/or tested for conformance to quality assurance specifications.

B. Power semiconductors shall be fully tested for proper electrical characteristics.

C. Each completed unit shall be functionally load tested prior to shipment to assure conformance to the specifications.

D. Testing shall be incompliance with Section 16060.

3.02 STARTUP & TRAINING

A. Bid price shall include 3 visits, consisting of a total of 5 days for startup and training. Services shall include startup of Starter(s) and field/classroom training for owner's personnel. Startup and training shall be provided by factory personnel or factory certified personnel.

B. Relay settings set in the field and shall be as provided in the overall project power system coordination study.

3.03 WARRANTY

A. Starter(s) furnished herein shall include a three (3) year manufacturer's warranty from date of acceptance on all solid state power sections and solid state control cards with two (2) year manufacturer's warranty from date of acceptance on other equipment provided.

END OF SECTION 16373

SECTION 16442

MINI-POWER CENTERS

PART 1- GENERAL

1.01 SCOPE

A. The Contractor shall furnish and install three-phase general purpose individually mounted mini-power centers of the two-winding type, self-cooled, as specified herein and as shown on the contract drawings.

1.02 REFERENCES

A. The mini-power center and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of ANSI and NEMA.

1.03 SUBMITTALS

A. The following information shall be submitted per Division 1:

1. Dimension drawing weights.
2. Technical certification sheet.
3. Transformer ratings including:
    a. kVA.
    b. Primary and secondary voltage.
    c. Taps.
    d. Primary and secondary continuous current.
    e. Insulation class and temperature rise.
    f. Sound level.
4. Component ratings including:
    a. Voltage.
    b. Continuous current.
    c. Interrupting ratings.
5. Cable terminal sizes.
6. Product data sheets.

B. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.

C. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if

any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

1.04 OPERATION AND MAINTENANCE MANUAL

A. The following information shall be submitted per Division 1:

1. Final (as-built) drawings and information for items listed in Paragraph 1.04, and shall incorporate all changes made during the manufacturing process.

2. Connection diagrams.

3. Installation information.

4. Instruction leaflets.

5. Instruction Bulletins.

6. Complete assembly.

1.05 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the secondary distribution equipment.

B. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years.

1.06 REGULATORY REQUIREMENTS

A. The assembly and all components shall be U.L. listed.

1.07 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

PART 2- PRODUCTS

2.01 MANUFACTURERS

A. Eaton.

B. General Electric.

C. Siemens.

D. Square D/Schneider Electric.

2.02 RATINGS

A. kVA and voltage ratings shall be as shown on the drawings.

B. Units shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96.

C. Transformer sound levels shall not exceed the following ANSI and NEMA levels for self-cooled ratings:

1. Up to 9 kVA 40 db

2. 10 to 30 kVA 45 db

2.03 CONSTRUCTION

A. Each mini-power center shall include a primary main breaker, an encapsulated dry-type transformer and a panelboard with secondary main breaker.

B. Primary main, secondary main and feeder breakers shall be enclosed with a pad lockable hinged door.

C. Mini-power centers shall be suitable for service entrance application.

D. Insulation Systems

1. Transformers shall be insulated with a 185 degrees C insulation system and rated at 115 degrees C temperature rise.

2. Required performance shall be obtained without exceeding the above-indicated temperature rise in a 40 degrees C maximum ambient, with a 30 degrees C average over 24 hours.

3. All insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM Standard Test Method D635.

E. Core and Coil Assemblies

1. Transformer core shall be constructed with high-grade, nonaging, silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point. The transformer core volume shall allow efficient transformer operation at 10% above the nominal tap voltage. The core laminations shall be tightly clamped and compressed. Coils shall be wound of electrical grade copper with continuous wound construction.

2. The core and coil assembly shall be completely encapsulated in a proportioned mixture of resin and aggregate to provide a moisture proof, shock-resistant seal. The core and coil encapsulation system shall minimize the sound level.

3. The core of the transformer shall be grounded to the enclosure.

4. Provide two (2) 5% FCBN taps.

2.04 BUS

A. Secondary bus shall be tin platted copper.

2.05 WIRING/TERMINATIONS

A. All interconnecting wiring between the primary breaker and transformer, secondary main breaker and transformer and distribution section shall be factory installed.

B. All transformers shall be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring.

2.06 MAIN DEVICES

A. Each mini-power center shall include a primary main breaker with an interrupting rating of 22kA at 277/480 volts; and a secondary main breaker with an interrupting rating of 10kA at 120/240 volts, and a panelboard.

2.07 FEEDER DEVICES

A. The secondary distribution section shall accommodate bolt-on breakers with 10 kA interrupting capacity.

2.08 ENCLOSURE

A. The enclosure shall be made of stainless steel and the maximum temperature of the enclosure shall not exceed 90 degrees C.

B. The enclosure shall be totally enclosed, no ventilated, NEMA 3R, SS316.

C. All the connection shall be bottom entrance to prevent water.

D. Connection shall be gasketed.

PART 3- EXECUTION

3.01 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA.

1. Ratio tests at the rated voltage connection and at all tap connections.

2. Polarity and phase-relation tests on the rated voltage connection.

3. Applied potential tests.

4. Induced potential test.

5. No-load and excitation current at rated voltage on the rated voltage connection.

3.02 INSTALLATION

A. The Contractors shall install all equipment per the manufacturer’s recommendations and the contract drawings.

3.03 FIELD ADJUSTMENTS

A. Adjust taps to deliver appropriate secondary voltage.

3.04 FIELD TESTING

END OF SECTION 16442

SECTION 16445

PANELBOARDS - DISTRIBUTION AND BRANCH CIRCUIT

PART 1- GENERAL

1.01 WORK INCLUDED

A. Furnish and install distribution and branch circuit panel boards.

1.02 REFERENCED STANDARDS

A. The following standards shall apply as if written here in their entirety:

1. UL 50 - Cabinets and Boxes.
2. UL 67 - Electric Panelboards.
3. NEMA AB 1 - Molded Case Circuit Breakers.
4. NEMA AB 2 - Procedures for Verifying the Performance of Molded Case Circuit Breakers.
5. NEMA KS 1 - Enclosed Switches.
6. NEMA PB 1 - Panelboards.

1.03 SUBMITTALS

A. The following information shall be submitted to the Engineer:

1. Breaker layout drawing with dimensions indicated and nameplate designation
2. Component list
3. Conduit entry/exit locations
4. Assembly ratings including:
    a. Short-circuit rating
    b. Voltage
    c. Continuous current
5. Cable terminal sizes

B. Submittal shall be clearly marked showing only equipment provided. Mark through equipment option not provided.

C. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.

D. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if

any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

PART 2- PRODUCTS

2.01 ENCLOSURE

A. Cabinet:

1. Construct cabinets in accordance with UL 50. Use painted galvanized sheet steel 16-gauge or more.
2. Provide a minimum 4-inch gutter wiring space on each side.
3. Reinforce cabinets and securely support bus bars and over-current devices to prevent vibration and breakage in handling.
4. Provide standard conduit knockouts in cabinet ends.
5. Finish cabinets of surface-mounted panelboards to match doors and trim as specified below.
6. Panelboards mounted outdoors shall be weatherproof, and shall have a door behind door type construction.
7. Panelboards mounted outdoor in wet or corrosive areas shall have NEMA 4X stainless steel 316 enclosures.
8. Panelboards mounted indoor shall be NEMA 12 enclosures for areas classified as NEMA 12.

B. Doors and Trim:

1. Fabricate doors and trim from cold-rolled sheet steel.
2. Equip doors with flush-type combination catch and key lock.
3. Key all locks alike. Fasten trim for flush-mounted panelboards to cabinets by an approved means which permits both horizontal and vertical adjustment.
4. Trim for surface-mounted panelboards must fit the cabinet with no overhang.
5. Apply a finish to trim and doors consisting of two coats of enamel over a rust-inhibiting prime coat.

2.02 BUS

A. Material:

1. Provide tin plated, copper bus bars, 98 percent IACS conductivity, full-sized throughout their length.
2. Use buses with tin-plated contact surfaces.
3. Include a tin plated copper bus bar ground bus in panelboard rated.

4. Full size (100% rated) insulated neutral bus shall be included in the panel board, shown with neutral. 200% rated neutral bus shall be supplied for panels designated on the drawings.

5. The ground and neutral bus shall be at least one terminal screw for each circuit.

6. Provide through feed or sub feed lugs where indicated.

7. Provide lugs and connection points on phase, neutral and ground bus suitable for copper conductors.

8. Spaces for future circuit breakers shall be bussed for the maximum devices that can be fitted.

B. Size bars as indicated and brace them to withstand the available symmetrical short circuit current.

C. Installation:

1. Install buses in allotted spaces so that devices can be added without additional machining, drilling or tapping.

2. Mount neutral bars, as required, on the opposite end of the main lugs.

2.03 PROTECTIVE DEVICES

A. Circuit Breakers: Provide circuit breakers for the specified service with the number of poles and ampere ratings indicated. All breakers 250A and above shall be 100% rated.

1. Provide breakers which are quick-make and quick-break on both manual and automatic operation.

2. Use a trip-free trip indicating breaker.

3. Incorporate inverse time characteristic by bimetallic overload elements and instantaneous characteristic by magnetic trip. Where indicated, provide ground fault circuit breakers (GFCB).

4. For 2-pole and 3-pole breakers, use the common-trip type so that an overload or fault on one pole will trip all poles simultaneously. Handle ties are not acceptable.

5. Unless otherwise indicated, provide circuit breakers with the following interrupting ratings:

a. Each circuit breaker used in 120/208 Volt panelboards shall have an interrupting capacity of not less than 10,000 Amps, RMS symmetrical.

b. Each circuit breaker used in 277/480 Volt and 480 Volt panelboards shall have an interrupting capacity of not less than 22,000 Amps, RMS symmetrical.

c. GFCI (ground fault circuit interrupter) shall be provided for circuits where shown on the drawings. GFCI units shall be 1 Pole, 120 Volt, molded case, bolt-on breakers, incorporating a solid state ground fault interrupter circuit insulated and isolated from the breaker mechanism. The unit shall be UL listed Class A Group I device (5 milliamp sensitivity, 25 millisecond trip time) and an interrupting capacity of 10,000 Amps, RMS.

d. Circuit breakers shall be as manufactured by the panelboard manufacturer.

6. Connect breakers to the main bus by means of a solidly bolted connection.

7. Use breakers which are interchangeable, capable of being operated in any position within the panel.

8. Independently mount breakers so that a single unit can be removed from the front of the panel without disturbing or removing main bus, other units or other branch circuit connections.

9. Provide individual breaker handle lock for all circuits that supply exit signs, emergency lights, and fire alarm panels.

10. Provide GFI circuit breakers for heat trace circuit. The rating shall be as per NEC.

B. Surge Suppressor

1. All the 480V panelboard shall be provided with TVSS in accordance with Specification 16289.

C. Service Entrance

1. The panelboard shall have a connection for housing and grounding neutral conductor.

2. Provide a UL label for the panelboard.

2.04 CIRCUIT IDENTIFICATION

A. Directory:

1. For each panelboard, provide a directory frame mounted inside the door with a heat-resistant transparent face and a directory card for identifying the load served.

2. Type directory as specified in Section 16010.

B. Nameplate:

1. Provide a black on white nameplate on the face of the panelboard using the following as an example:

Panel HA
277/480V, 30, 4W
Feeder from MCC-B/Section

2. The nameplate shall have a minimum thickness of 1/8".

2.05 LISTING

A. UL 67 - Electric Panelboards.

2.06 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers are General Electric, Siemens, and Square D.

PART 3- EXECUTION

3.01 INSTALLATION

A. Install panelboards in the locations as shown and as recommended in NEMA PB1.1.

B. In wet and corrosive areas, including outdoor locations, install stainless steel 316 panelboard enclosures on Type 316 stainless steel unistrut support to provide clearance behind the mounting surface.

C. In wet and corrosive areas, including outdoor locations, connect conduits to the bottom of the enclosure and to the lower 30 percent of the sides.

D. All conduit connections shall be by use of Myers hub.

3.02 MOUNTING HEIGHT

A. Install the panelboards such that the center of the switch or circuit breaker in the highest position will not be more than 6-1/2 feet above the floor or working platform.

3.03 SPECIAL REQUIREMENTS

A. All copper items, including wiring, terminal blocks, lugs, connectors, bus, etc., shall be tin plated copper.

B. All steel shall be primed and painted as specified. Galvanized items shall also be painted.

C. All hardware, including nuts, bolts, washers, screws, anchor bolts, door hinges, etc., shall be made of 316 stainless steel.

D. The panelboard steel parts shall be cleaned and sprayed in control cleaning solutions by a multi-stage spray washer. The operation shall produce a coating of a minimum of 150milligrams per square foot to meet MIL Specification TT-C490. The primed metal parts shall be electrostatically coated with power paint to a thickness of 2.5mils. The paint finish shall withstand a minimum of 1000hours salt spray test.

END OF SECTION 16445

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SECTION 16450

GROUNDING

PART 1- GENERAL

1.01 WORK INCLUDED

A. Furnish and install grounding and bonding equipment for the electrical system. It is the intention of this specification that all electrical equipment be grounded. Furnish labor, materials, equipment and incidentals necessary to install a complete grounding system in strict accordance with Article 250 of the National Electrical Code (NEC) as shown on the drawings or as specified herein. Electrical work shall be in accordance with Section 16010, GENERAL ELECTRICAL REQUIREMENTS.

1.02 REFERENCE STANDARDS

A. The following standards shall apply as if written here in their entirety:

1. ANSI/IEEE Standard 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

2. ANSI/UL 467 - Grounding and Bonding Equipment.

3. National Electrical Code.

1.03 SUBMITTALS

A. Submittal shall be in accordance with Division 1 and shall include:

1. Grounding materials, equipment and processes.

2. Product Data: For each type of product supplied.

3. Field quality-control test reports.

B. Submittal shall be clearly marked showing only equipment provided. Mark through equipment option not provided.

C. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.

D. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with UL 467 for grounding and bonding materials and equipment.

1.05 JOB CONDITIONS

A. Measure the ground grid resistance with the earth test megger and install additional ground rods and conductors as required until the resistance to the ground conforms to National Electrical Code requirements. Ground resistance measurement shall not exceed 5 ohms.

PART 2- PRODUCTS

2.01 GROUND RODS

A. Material: GROUND RODS: Solid Copper, having a diameter of 3/4" and a minimum length of 10'.

B. Listing: UL 467

2.02 GROUND CABLES

A. Stranded, bare tinned copper of 98% conductivity and as specified in Section 16120 600 VOLT WIRE AND CABLES.

2.03 CONDUIT GROUND FITTINGS

A. Fittings for bonding ground cable to the conduit shall be FCI Burndy Corp., type NE or Thomas & Betts No. 3951 series.

2.04 GROUND ROD BOXES

A. Precast Box with cast iron lid. Lid shall read “ground rod” on lid. Brooks Precast Model. “3-RT” or approved equal. Ground rod boxes located in driveway areas shall have an AASHO H-20 rating.

2.05 GROUND PLATE ELECTRODES

A. 20 gauge copper with terminated two (2) foot welded pigtail connection.

2.06 CONNECTIONS

A. Type:

1. Unless otherwise noted, provide exothermic weld typed for all non-accessible and below-grade connections.

2. For above grade connections provide bonds and clamps of a nonferrous material which will not cause electrolytic action between the conductor and the connector.

B. Listing: UL 467

C. Acceptable Manufacturers:

1. Below grade: Cadweld, Thermoweld

2. Above grade:

a. Burndy

b. Ilsco

c. OZ/Gedney

d. T & B

2.07 CERTIFICATION

A. Contractor shall receive from the manufacturer proper training prior to execute the exhotermic weld connection.

2.08 WIRING

A. Provide copper insulated conductors for bonding jumpers. All insulated grounding conductors shall be copper, stranded.

1. Provide 600-volt insulated conductors having a green-colored XHHW insulation for equipment grounding conductors.

2. Ground conductors shall be protected in conduit where subject to physical damage.

3. All exposed ground conductors shall be installed in conduits. Ground conductor attached to cable trays shall not be considered exposed.

2.09 GROUND BUS

A. Round-edge tin plated copper bar with 98 percent International Annealed Copper Standard (IACS) conductivity.

B. Size the bus for not less than 25 percent of the cross-sectional area of the related feeder.

C. A minimum ground bus size of 3-inch by 2 inches is required.

2.10 GROUNDING FOR INSTRUMENTATION SYSTEM

A. Ground Loop for instrumentation system shall be grounded at only one point to the building ground system.

2.11 GROUND LOOP

A. All ground loop conductor shall be bare copper minimum wire size shall be #3/0 unless otherwise noted.

PART 3- EXECUTION

3.01 SYSTEM GROUND

A. System Neutral:

1. Where a system neutral is used, ground the system neutral conductor as required by NEC Article 250.

2. Ground the system neutral only at the point of service and isolate it from ground at all other points in the system.

B. Separately Derived Systems: Ground neutrals of separately derived systems such as generators, transformers, etc., in accordance with NEC 250-30.

C. Size: Size the system grounding conductors to comply with NEC Table 250-66, unless shown larger.

3.02 EQUIPMENT GROUND

A. Raceway Systems and Equipment Enclosures:

1. Ground cabinets, junction boxes, outlet boxes, motors, controllers, raceways, fittings, switchgear, transformer enclosures, handrail, stair, steel pipe and other equipment and metallic enclosures.

2. Ground equipment and enclosures to the continuous-grounded, metallic raceway system in addition to any other specific grounding shown.

3. Provide bonding jumpers and ground wire throughout to ensure electrical continuity of the grounding system.

4. Provide grounding-type insulated bushings for metal conduits terminating in equipment enclosures containing a ground bus and connect the bushing to the ground bus.

5. Provide green insulated equipment grounding conductor for each feeder, power branch circuit, receptacle branch circuit and lighting branch circuit.

6. Raceways shall not be used for equipment ground. Provide individual equipment ground wires for all equipment even if not shown on plans.

7. Provide bonding jumper and bonding bushing on each metallic conduit entering or leaving the enclosure of the service equipment.

8. Where grounding conductors are shown, bond the wires to metallic enclosures at each end and to intermediate metallic enclosures. Connect grounding conductors to grounding bushings on raceway. Where any equipment contains a ground bus, extend and connect grounding conductors to that bus. Run ground conductor inside conduits enclosing the power conductors.

9. Make connections of any grounding conductors to motors ½ HP and above, or circuits 20 amps or above, by solderless terminal and a 5/16-inch minimum bolt tapped to the motor frame or equipment housing. Grounding clips mounted directly on the box, or with 3/8-inch machine screws. Completely remove all paint, dirt, or other surface coverings at grounding conductor to connection points to that good metal-to-metal contact is made.

10. Ground metal sheathing and any exposed metal vertical structural elements of buildings. Ground metal fences enclosing electrical equipment. Bond any metal equipment platforms which support electrical equipment to that equipment. Provide good electrical contact between metal frames and railings supporting pushbutton stations, receptacles, instrument cabinets, etc., and raceways carrying circuits to these devices.

11. Bond neutrals of transformers to the system ground network, and to any additional indicated grounding electrodes.

B. Size:

1. When grounding and bonding conductors are not sized on drawings, size the grounding conductors in accordance with NEC Table 250-122.

2. Size bonding jumper so that minimum cross-sectional area is greater than or equal to that of the equivalent grounding conductor as determined from NEC Table 250-122.

C. Install sufficient ground rods in addition to those shown, or code required grounding so that resistance to ground as tested by standard methods does not exceed 1 ohm. Where more than one rod is required, install rods at least 6 feet apart.

3.03 GROUND CONNECTIONS

A. Unless shown otherwise, make connections of grounding conductors to ground rods at the upper end of the rod with the end of the rod and the connection point below finished grade.

B. Make connections of sections of outdoor ground mats (counterpoise) for substations or other equipment underground. Make connections of other grounding conductors generally accessible.

C. When making thermite welds, wire blush or file the point of contact to a bare metal surface. Use thermite welding cartridges and molds in accordance with the manufacturer's recommendations. After welds have been made and cooled, brush slag from the weld area and thoroughly clean the joint. For compression connectors, use homogeneous copper, anti-corrosion, surface treatment compound at connectors in accordance with connector manufacturer's recommendations. Use connectors of proper size for conductors and ground rods specified. Use connector manufacturer's compression tool. Notify Engineer prior to backfilling any ground connections.

3.04 FIELD TEST

A. The testing shall be performed in accordance with Section 16060.

END OF SECTION 16450

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SECTION 16496

480V AUTOMATIC TRANSFER SWITCHES

PART 1- GENERAL

1.01 SCOPE

A. Furnish and install automatic transfer switches (ATS) with number of poles, amperage, voltage, and withstand current ratings as shown on the plans. Each automatic transfer shall consist of an inherently double throw power transfer switch unit and a microprocessor controller, interconnected to provide complete automatic operation.

1.02 ACCEPTABLE MANUFACTURERS

A. Automatic transfer switches shall be ASCO Series 300 or equal by Ruselectric. Any other alternate shall be submitted for approval to the consulting Engineer at least 10 days prior to bid. Alternate bids must list any deviations from this specification.

1.03 CODES AND STANDARDS

A. The automatic transfer switches and accessories shall conform to the requirements of:

1. UL 1008 - Standard for Automatic Transfer Switches
2. NFPA 70 - National Electrical Code
3. NFPA 110 - Emergency and Standby Power Systems
4. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
5. NEMA Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches
6. NEC Articles 700, 701, 702
7. International Standards Organization ISO 9001: 2000
8. UL891 Suitable for use only as service equipment
9. UL 508 Industrial Control Equipment

PART 2- PRODUCTS

2.01 MECHANICALLY HELD TRANSFER SWITCH

A. The transfer switch unit shall be electrically operated and mechanically held. The electrical operator shall be a single-solenoid mechanism, momentarily energized. Main operators which include overcurrent disconnect devices will not be accepted. The switch shall be mechanically interlocked to ensure only one of two possible positions, normal or emergency.

B. The switch shall be positively locked and unaffected by momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life.

C. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. A manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to manually stop the contacts at any point throughout their entire travel to inspect and service the contacts when required.

D. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.

E. Where neutral conductors must be switched as shown on the plans, the AS shall be provided with fully rated overlapping neutral transfer contacts. The neutrals of the normal and emergency power sources shall be conneceted together only during the transfer and retransfer operation and remain connected together until power source contacs close on the source to which the transfer is being made. The overlapping neutral contacts that do not overlap are not acceptable.

F. Where neutral conductors are to be solidly connected as shown on the plans, a neutral conductor plate with fully rated AL-CU pressure connectors shall be provided.

2.02 MICROPROCESSOR CONTROLLER WITH MEMBRANE INTERFACE PANEL

A. The controller shall direct the operation of the transfer switch. The controller's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability, minimum maintenance, and inherent serial communications capability. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance.

B. The controller shall be enclosed with a protective cover and be mounted separate from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers.

C. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:

1. ANSI C37.90A/IEEE 472 Voltage Surge Test
2. NEMA ICS – 109.21 Impulse Withstand Test
3. IEC801-2 Electrostatic discharge (ESD) immunity
4. ENV50140 and IEC 801 – 3 Radiated electromagnetic field immunity
5. IEC 801 – 4 Electrical fast transient (EFT) immunity
6. ENV50142 Surge transient immunity
7. ENV50141: Conducted radio-frequency field immunity
8. EN55011: Group 1, Class A conducted and radiated emissions
9. EN61000 –4 – 11 Voltage dips and interruptions immunity

2.03 ENCLOSURE

A. The ATS enclosure shall be NEMA Type 4X Stainless Steel 316.

PART 3- OPERATION

3.01 VOLTAGE AND FREQUENCY SENSING

A. The voltage of each phase of the normal source shall be monitored, with pickup adjustable to 95% of nominal and dropout adjustable from 70% to 90% of pickup setting.

B. Single-phase voltage and frequency sensing of the emergency source shall be provided.

3.02 TIME DELAYS

A. An adjustable time delay shall be provided to override momentary normal source outages and delay all transfer and engine starting signals.

B. An adjustable time delay shall be provided on transfer to emergency, adjustable from 0 to 5 minutes for controlled timing of transfer of loads to emergency.

C. An adjustable time delay shall be provided on retransfer to normal, adjustable to 30 minutes. Time delay shall be automatically bypassed if emergency source fails and normal source is acceptable.

D. All adjustable time delays shall be field adjustable without the use of special tools.

3.03 ADDITIONAL FEATURES

A. A set of contacts rated 5 amps, 32 VDC shall be provided.

B. A push-button type test switch shall be provided to simulate a normal source failure.

C. A push-button type switch to bypass the time delay on transfer to emergency.

D. Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal.

E. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact, closed, when the ATS is connected to the emergency source.

F. Indicating lights shall be provided, one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red). Also provide indicating lights for both normal and emergency source availability.

G. Terminals shall be provided to indicate actual availability of the normal and emergency sources, as determined by the voltage sensing pickup and dropout settings for each source.

H. Inphase Monitor - An Inphase monitor shall be inherently built into the controls. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents, and shall not require external control of power sources. The inphase monitor shall be specifically designed for and be the product of the ATS manufacturer.

I. Selective Load Disconnect - A double throw contact shall be provided to operate after a time delay, adjustable to 20 seconds prior to transfer and reset 0 to 20 seconds after transfer. This contact can be used to selectively disconnect specific load(s) when the transfer switch is transferred. Output contacts shall be rated 6 amps at 28 VDC or 120 VAC.

PART 4- ADDITIONAL REQUIREMENTS

4.01 WITHSTAND AND CLOSING RATINGS

A. The ATS shall be rated to close on and withstand the available rms symmetrical short circuit current at the ATS terminals with the type of overcurrent protection shown on the plans. WCR ATS ratings as be as follows when used with specific circuit breakers:

ATS Size	*Withstand & Closing Rating MCCB*	*W/CLF*
30	22,000A	100,000
70 - 200	22,000A	200,000
230	22,000A	100,000
260 – 400	42,000A	200,000
600 – 1200	65,000A	200,000
1600 – 2000	85,000A	200,000
2600 – 3000	100,000A	200,000

4.02 TESTS AND CERTIFICATION

A. The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

B. The manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.

C. The ATS manufacturer shall be certified to ISO 9001: 2000 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001: 2000.

4.03 SERVICE REPRESENTATION

A. The ATS manufacturer shall maintain a national service organization of company-employed personnel located throughout the contiguous United States. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.

B. The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years.

C. For ease of maintenance, the transfer switch nameplate shall include drawing numbers and serviceable part numbers.

END OF SECTION 16496

SECTION 16600

LIGHTING

PART 1- GENERAL

1.01 WORK INCLUDED

A. Furnish and install complete lighting and receptacle systems, including lighting fixtures, receptacles, switches, and all accessories and appurtenances as shown on the drawings and as specified herein.

1.02 REFERENCED STANDARDS

A. The following standard shall apply as if written here in their entirety:

1. ANSI C78 – Fluorescent Lamps.
2. ANSI C78 – High-Intensity-Discharge Lamps.
3. ANSI C78 – Incandescent Lamps.
4. ANSI C82 – Lamp Ballasts.
5. ANSI/UL 844 – Safety Standard for Electrical Lighting Fixtures for Use in hazardous Locations.
6. ANSI/UL 935 – Safety Standard for Fluorescent Lamp Ballasts.
7. ANSI/UL 1029 – High-Intensity-Discharge Lamp Ballasts.
8. NEMA FA 1 – Outdoor Floodlighting Equipment.
9. NEMA LE 1 – Fluorescent Luminaires.
10. NEMA LE 3 – Manual for High-Intensity-Discharge (H-I-D) Lamps.
11. UL 57 – Electric Lighting Fixtures.

1.03 SUBMITTALS

A. Submit shop drawings showing complete construction details for all equipment in compliance with Division 1 - General Provisions.

B. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.

1.04 QUALITY ASSURANCE

A. Lighting fixtures shall be in compliance with the National Electrical Code, and shall be constructed in compliance with the Underwriters' Laboratories "Standards for Safety, Electric Lighting Fixtures". Lighting fixtures shall be Underwriters' Laboratories labeled.

PART 2- PRODUCTS

2.01 MATERIALS

A. Lighting Fixtures: Lighting fixture types shall be as shown in the "Lighting Fixture Schedule" on the drawings. The catalog numbers listed are given as a guide to the design and quality of fixtures desired. Equivalent designs and equal quality fixtures of other approved manufacturers shall be acceptable.

B. Lamps:

1. Fluorescent lamps shall be T8 bi-pin and rapid start, standard cool white with wattage rating as indicated in the "Fixture Schedule".

2. Fluorescent ballasts shall be Class P, rapid start, high power factor, CBM certified by E.T.L., and listed by Underwriters' Laboratories, Inc. for operation on 120 volt 60 hertz, and as indicated in the "Fixture Schedule".

3. Emergency ballasts for fluorescent fixtures shall consist of a battery, charger, and electronic circuitry contained in a single, compact enclosure, and shall be as indicated in the “Fixture Schedule”. Test switch and charging indicator light shall be externally mounted on fixture housing.

4. High intensity discharge (H.I.D.) lamps shall be deluxe white, or clear, of the size and type as specified in the "Lighting Fixture Schedule" on the drawings.

5. High intensity discharge (H.I.D.) ballasts shall be of the constant wattage auto-transformer type. All ballasts shall be of the correct size and voltage for the fixture it is to serve as specified in the "Lighting Fixture Schedule" on the drawings.

6. All HID fixtures shall be equipped with constant wattage, high poser factor ballasts. Ballast noise under loaded conditions shall not exceed 55 dbA at three feet for each ballast.

7. All HID lamp sockets shall be mogul base, porcelain screw shell.

C. 24-Hour Programmable Timers

1. Unless otherwise specified, time switches shall be of the programmable type capable of being programmed at the intervals as noted on the Drawings over a 24-hour day. Program tabs shall be easily set by hand without tools to obtain or to change the desired programming schedule. The switching condition shall be maintained when adjacent tabs are set alike.

2. The unit shall be powered by a self-starting, enclosed, 120 Volt, synchronous motor capable of continuous accurate operation. A reserve power, precision wound spring and associated escapement device shall be integrally mounted to maintain time settings during power failures of up to 24 hours.

3. The switch mechanism shall be a self-contained unit rated at not less than 20 Amps, 120 Volts, single pole, double throw and shall be readily replaceable in the field.

4. An omitting device shall be furnished as an integral part of the time switching operation to be skipped for any preselected day or days of the week.

5. Unless otherwise specified, time switches shall be as manufactured by Intermatic; TORK; Paragon or approved equal.

6. Used for fan control, not used for lighting loads.

D. Photocells

1. The photocells shall be suitable for power duty with individual fixtures or for pilot duty with contactors as detailed on the Drawings.

2. 480V Photocell shall be Precision P7275 or approved equal.

3. 120V Photocell shall be Precision P2275 or approved equal.

4. 208V – 277VAC Photocell shall be Precision P68275 or approved equal.

5. Locking type receptacle shall be Precision M2A or approved equal.

E. Lighting Contactor

1. Lighting contactor 60A and above shall be of the electrically operated, mechanically held type mounted in NEMA 1, enclosures (except where noted otherwise on the Drawings) with number of poles as noted on the Drawings. Operating coils shall be rated for 120 Volts unless otherwise indicated on the Drawings and shall be for momentary operation. Provide with "Hand-Off-Auto" switch on cover where shown on the Drawings.

2. Lighting contactor below 60A shall be of the electrically operated, electrically held type mounted in NEMA 1, enclosures (except where noted otherwise on the Drawings) with number of poles as noted on the Drawings. Operating coils shall be rated for 120 Volts unless otherwise indicated on the Drawings and shall be for momentary operation. Provide with "Hand-Off-Auto" switch on cover where shown on the Drawings.

3. Contactors shall be rated for 20 Amps, 600 VAC and shall be Automatic Switch Co., Bulletin 917 RC, similar by Square D Co.; or approved equal.

PART 3- EXECUTION

3.01 COORDINATION

A. Verify that the lighting fixtures are compatible with the specified ceiling systems as indicated on the architectural drawings.

B. Advise the Engineer of any discrepancies before placing the lighting fixture order.

3.02 LIGHTING INSTALLATION

A. Fixtures must be completely wired and lamps installed.

B. Lighting fixtures must be operating properly at final completion.

C. Provide hangers and support members for fixtures as required for proper installation.

D. Provide appurtenances which include stud supports, stems, mounting brackets, frames, and plaster rings.

E. Support fixtures from the building structure, or from furring channels. Furring channels must be a minimum of 1-1/2 inches wide.

F. Flexible metal conduit from junction box to lighting fixture shall not touch the ceiling as finally installed.

END OF SECTION 16600

SECTION 16901

INSTRUMENTATION AND CONTROLS

PART 1- GENERAL

1.01 SCOPE

A. Furnish and install all instruments, control devices, and associated equipment as described herein and in the Drawings, or as required, to provide a complete and functional-instrumentation and control system, including all hardware, software, materials, labor, and consumables.

B. Ancillary equipment required for proper system installation and operation, including interconnecting cables, relays, signal converters/isolators, terminal blocks, fuses, din rail, connectors, installation and mounting hardware shall be furnished and installed whether specified or not.

C. All system components shall be assembled, installed, configured, calibrated, tested, and commissioned as described in the Contract Documents and in full compliance with-the directions and recommendations of the equipment manufacturer and the ENGINEER.

D. Where practical, similar instruments, control devices, hardware, and other system components shall be of a single, reputable, well-established manufacturer as specified herein or as otherwise approved by the ENGINEER.

E. Substitution of equipment and system functions will not be accepted unless explicitly approved by the ENGINEER.

1.02 RELATED WORK

A. Related sections that apply to this section include but are not necessarily limited to the following:

1. Section 16010 “General Electrical Requirements”
2. Section 16902 “Control Panels”
3. Section 16951 “Testing Instrumentation and Controls”
4. Section 16904 “SCADA Radio System”
5. Section 16950 “Calibration and Testing”

1.03 REFERENCED STANDARDS

A. The following standards apply to this section:

1. Instrument Society of America (ISA)
    a. ISA S5.1 Instrument Symbols
    b. ISA S5.4 Loop Diagrams
2. NFPA 70 National Electric Code (NEC)
3. National Electrical Manufactures Association (NEMA)

a. NEMA 250 Enclosures for Electrical Equipment

4. ICS 6 Enclosures for Industrial Controls and Systems

5. Underwriters Laboratories (UL)

6. City of San Antonio

B. Where reference is made to any of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 SUBMITTALS

A. Submit to the ENGINEER, in accordance with Section 16010, copies of all materials required to establish compliance with this Section. At a minimum, submittals shall include the following:

1. Manufacturers' data sheets providing:

a. Manufacturer and model number

b. Physical description

c. Specifications

d. Certification of compliance with referenced standards

2. Installation Instructions

a. Site planning requirements

b. Mounting and orientation diagrams

c. Signal and power wiring diagrams

3. Check-out and Testing

a. Wiring/Loop check procedure and check list

b. Functional test procedures and check list

c. Owner acceptance documentation

4. Start-up Instructions

a. Set-up and configuration procedures

b. Special service recommendations

c. Instrument scales in engineering units

5. Maintenance Instructions

a. Field calibration procedures

b. Calibration equipment requirements

c. Factory calibration certificate as applicable

6. Warranty information

a. Two year minimum warranty

b. Installation and field support

1.05 QUALITY ASSURANCE

A. The complete instrumentation and control system shall be furnished and installed by a single, qualified supplier who is regularly engaged in the design and implementation of similar systems for the water/wastewater industry.

B. Instruments, control devices, hardware, and other system components shall be new and of standard models, distributed and serviced by reputable, well-established manufacturers as approved by the ENGINEER. Custom or one-of-a-kind components will not be accepted.

C. Upon completion of installation and checkout, the instrumentation and control system shall function as described herein and on the Drawings and will be tested and documented to the satisfaction of the ENGINEER.

1.06 MAINTENANCE

A. Supplier shall furnish all special tools, equipment, and software required for normal adjustment, calibration, and maintenance of all instrumentation and controls equipment.

B. Supplier shall furnish all documentation and special training required for the normal adjustment, calibration, and maintenance of all instrumentation and controls equipment.

C. Supplier shall furnish the following spare parts:

1. One power supply for each ten units or fraction thereof furnished

2. One surge suppressor for each ten units or fraction thereof furnished

3. Ten spare fuses of each type and size furnished

4. Ten lamps of type and size furnished

5. One relay for each twenty or fraction thereof of each type furnished

1.07 DELIVERY, STORAGE, AND HANDLING

A. Product delivery, storage and handling shall comply with Section 16010.

B. Equipment and materials shall be shipped to the jobsite in appropriate packing and/or crating so as to prevent damage during shipment.

C. Equipment and materials shall be delivered to the site in a timely manner to ensure uninterrupted progress of the work.

D. Only new equipment and materials, meeting the specifications, shall be accepted at the jobsite.

E. Upon delivery to the jobsite, all equipment and materials shall be immediately inspected, and any damaged equipment or materials shall be rejected.

F. All equipment and materials shall be handled with care. All process connections on instrumentation shall be sealed to prevent contamination by foreign material or moisture.

G. Equipment and materials shall be stored so as to permit easy access for identification and inspection.

H. All equipment and materials that are stored on site shall be adequately protected from damage.

I. Off-site equipment and material storage shall be climate-controlled.

J. All equipment and materials shall be covered to prevent damage. All equipment and materials susceptible to damage from sunlight, rain, hail, sleet, snow, wind, and other elements shall be adequately protected so as to prevent such damage.

PART 2- PRODUCTS

2.01 LIFT STATION MEASURING SYSTEM

A. General:

1. The wetwell level measuring system shall consist of sensor installed in the wetwell and a transmitter installed in the control panel.

2. Sensor shall be of the solid-state head-pressure sensing type, suitable for continuous submergence and operation and shall be installed in accordance with manufacturer's instructions.

3. The transducer assembly shall be connected with the sensor and placed in successful operation. It shall be provided with input power and output signal transient protection, associated control elements as specified herein and in accordance with manufacturer's instructions.

4. Provide an intrinsically safe barrier between the upper and lower assemblies. The barrier shall render the level sensing system suitable for use in Class 1, Division 1 Groups A, B, C and D, Class 2, Division 1, Groups E, F and G, and Class 3, Division 1 hazardous locations.

5. The transducer shall be a 4-20 mAdc, 2-wire, 15 to 30 VDC loop-powered type with its output signal directly proportional to the measured level excursion over a factory-calibrated range.

6. The use of the manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and typical configuration desired.

7. The transducer shall be connected to the sensor by a cable furnished with the sensor.

B. Construction:

1. The transducer housing shall be fabricated of type 316 stainless steel with a barrier diaphragm.

2. The transducer shall be temperature compensated.

3. The transducer element shall incorporate high over-pressure protection and be designed to withstand intermittent overpressures two times the full-scale range being sensed. Sensing principles employing LVDTs, resistive or pneumatic elements shall not be acceptable.

4. The internal pressure of the lower transducer assembly shall be relieved to atmospheric pressure though a heavy-duty urethane jacketed hose/cable assembly and a slack PVC bellows assembly. The sealed breather system shall compensate for variations in barometric pressure and expansion and contraction of air due to temperature changes and altitude as well as prevent fouling from moisture and other corrosive elements.

C. Functional Requirements:

1. Performance

2. Outputs: 4-20 Ma

3. Loop Power: Isolated 24 VDC at 20 mA regulated

4. Output Loop Resistance: 600 Ohms maximum

D. Tools, Spare Parts, and Accessories:

1. Any additional spare parts recommended by the manufacturer shall be provided.

E. Manufacturer:

1. Transducer shall be Mercoid Dwyer Model PBLTX. Intrisically safe barrier shall be Mercoid Dwyer Model # MTL7706/7787 with range as required by depth of wetwell, or approved equal.

2. Transmitter shall be Siemens HydroRanger 200 (Model 7ML1034-3AA11) having the following features:

a. Analog Output: isolated 4-20mADC proportional to level, minimum 75052. total burden; 0.1% programmed range resolution

b. Relay contact outputs: Four control relays, form A, N.O., rated 5A @ 250VAC non-inductive; two alarm relays, form C, N.O./N.C., rated 5A @ 250VAC non-inductive.

c. Control Functions: Pump down and lead pump alternate

d. Display: Integral, back-lit LCD display to indicate level and relay settings in engineering units

e. Enclosure: Suitable for panel mount.

f. Power: 120VAC, 60Hz

g. Programming: Hand-held or PC-based

2.02 LEVEL SWITCHES

A. Type: Sealed, eccentric tilting float type, mercury-free float switch.

B. Performance

1. Weighted float to hang vertically when not immersed and tilt when immersed.

C. Features:

1. One SPDT switch rated 5A @ 120VAC.
2. Hermetically sealed polypropylene or PTFE body as appropriate for wastewater application.
3. Heavy duty, three conductor, PVC jacketed cable with watertight seal to switch body.

D. Acceptable Manufacturers:

1. Flygt ENM-10.
2. Engineer approved equal.

2.03 DISCHARGE PRESSURE INDICATING TRANSMITTER

A. Electronic gauge pressure indicating transmitter.

B. Performance:

1. Accuracy: 0.1% calibrated span.
2. Stability: 0.1% Upper range limit.
3. Temperature: -40 to 85C (-40 to 185F).
4. Maximum operating pressure: 150 psi minimum.

C. Features:

1. All stainless steel construction.
2. 4-20 mAdc analog output directly proportional to the measured pressure, 500 Ohm total burden with 24 Vdc loop power.
3. HART protocol module for integration into the PLC..
4. 2-wire, 24 Vdc loop powered.
5. Integral LCD display indicating pressure in psi.
6. Stainless steel mounting bracket and bolts.

D. Acceptable Manufacturers:

1. Rosemont 2088GS22A1B4E5M5.
2. Engineer approved equal.

2.04 DISCHARGE PRESSURE GAUGE

A. Mechanical pressure gauge with 4 ½" dial, 0-100 PSI range, stainless steel rotary geared Teflon movement, hermetically sealed aluminum solid front housing. Furnish with brass fittings, stopcock and a pressure snubber.

B. Pressure gauge shall be Ashcroft 1379 Duragauge, or Engineer approved equal.

2.05 PROCESS VARIABLE INDICATORS

A. Furnish digital process variable indicators on the control panels as indicated on the drawings.

B. Meters shall be digital type 120 Vac powered, with 0.5" minimum, 4 ½ digit, segmented red LED display, 4-20 mAdc process variable input, integral isolated 24 Vdc loop power supply, non-volatile program memory.

C. Meters shall be Newport Electronics 202A-P, or Engineer approved equal.

2.06 PANELS

A. Refer to Section 16902 for panel specifications.

2.07 24VDC POWER SUPPLIES

A. Type: Industrial grade 24VDC Switching Power Supply

B. Performance

1. Input: 120VAC +/- 10%, 60Hz
2. Output: 1 X 24VDC, <50mVpp ripple
3. Output current rating 125% of connected load
4. Output protected against open circuit, short circuit and overload with auto-recovery
5. Class I (IEC 536) transient/surge protection meeting IP20 (IEC 529)
6. Operating temperature: 14-140°F without derating. Meets UL 508

C. Features

1. Din-rail mounted.
2. Finger-safe terminals.
3. LED indicator light to indicate presence/health of 24VDC output.

D. Acceptable Manufacturers

1. IDEC model PS5R-SC24.
2. Engineer approved equal

2.08 CONTROL RELAYS

A. Type: General purpose, electromechanical control relays

B. Performance

1. Coil: 120VAC, 60Hz unless otherwise indicated on the Drawings.
2. Contacts: 240VAC, 10A resistive.

3. Operating temperature: -40 to 131 °F

C. Features

1. Sealed construction for protection against moisture and contaminants
2. Silver cadmium oxide contact material
3. Din-rail mountable socket base
4. Indicator to indicate presence of coil voltage

D. Acceptable manufacturers

1. IDEC RH2B-UL-12O w/ SH2B-05 socket.
2. Engineer approved equal

2.09 TIMING RELAYS

A. Type: Solid state, microprocessor-controlled, electromechanical timing relay

B. Performance

1. Coil voltage: 120VAC, 60Hz unless otherwise indicated on the drawings
2. Contacts: 240VAC, 10A resistive
3. Operating temperature: -4 to 131 °F

C. Features

1. Sealed construction for protection against moisture and contaminants
2. Silver cadmium oxide contact material
3. Tubular, eight or eleven-pin plug-in terminal configuration with din-rail mountable socket base
4. Timing function as indicated on the Drawings
5. Field programmable timing ranges from 0.1 seconds to 600 hours
6. Dial or rotary switches for selection of timing range and time delay
7. LED pilot light(s) to indicate when relay is timing and when relay is timed out

D. Acceptable Manufacturers

1. Square D Type JCK
2. Eaton/Cutler Hammer TR Series
3. Engineer approved equal

2.10 PUSHBUTTONS, SELECTOR SWITCHES, AND INDICATING LIGHTS

A. Type: 30.5mm pushbuttons, selector switches, and indicating lights

B. Performance

1. NEMA 4/13, oil-tight, dust-tight, water-tight
2. Silver alloy contacts rated 240VAC, 10A resistive
3. 120VAC, transformer type LED indicating lights with push-to-test feature.
4. Operating temperature: 1 to 150°F

C. Features

1. Heavy duty, zinc die cast operator construction
2. Finger proof terminals on contact blocks and indicator light modules
3. Pushbutton operators to be flush head type with momentary action unless indicated otherwise on the Drawings
4. Stop pushbutton operators to be red; all other pushbutton operators to be black unless indicated otherwise on the Drawings
5. Selector switches to be maintained action unless indicated otherwise on the Drawings
6. Pushbuttons and selector switches to have one spare normally open and one spare normally closed contact beyond the number required by the Drawings
7. Indicator light lamps to be removable from the front of the unit
8. Indicator light lens color as indicated on the Drawings

D. Acceptable manufacturers

1. Square D Type 9001 K
2. Eaton/Cutler Hammer 10250T
3. Engineer approved equal

2.11 TERMINAL BLOCKS

A. Type: Feed-through, fused, and grounding terminal blocks

B. Performance

1. Rated voltage: 600V
2. Rated surge voltage: 8kV
3. Maximum current: 41 A

C. Features

1. Din rail mountable
2. Width: 6.2mm

3. Number of levels: 1
4. Number of connections: 2
5. Connection type: screw terminal
6. Wire size: 26-10AWG 7. Color
    a. Feed-through terminal blocks: Grey
    b. Fused terminal blocks: Grey or black
    c. Ground terminal blocks: Green/yellow
7. Fused terminal blocks to have LED blown fuse indicator
8. End barriers, end clamps, jumpers, labels and all other terminal block accessories to be of the same manufacturer as terminal blocks

D. Acceptable Manufacturers

1. Phoenix Contact
2. Engineer approved equal

2.12 RECEPTACLES

A. Furnish and install receptacles as shown on the Drawings.

B. Receptacles shall be GFCI and shall be as specified in Section 16140 - Wiring Devices.

C. Furnish and install a cast aluminum box for each receptacle.

D. For each exterior receptacle, furnish and install a stainless steel, waterproof cover.

E. For each receptacle installed inside an enclosure, furnish and install a white or ivory nylon cover.

2.13 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. General

The PLC shall be a complete system that includes, but is not limited to, the following:

1. Processor
2. PLC modules, chassis and power supply
3. Connection buses
4. All connection cables

B. Features:

1. RS232 communications port dedicated for communications with and compatible with the SCADA radio system specified in Section 16904 – Scada Radio Systems and the SAWS SCADA system.

2. RS232 communications port dedicated for programming; the communications port dedicated for communications with the SCADA system shall not be used for programming the PLC

3. Battery backup of program memory or flash memory.

C. Acceptable Manufacturers

1. Allen Bradley Compact Logix 1769-L32E consisting of the following:

   a. 1.5 MB user memory.

   b. 64 MB Compact flash card.

   c. One eight-slot backplane with available space for up to 8 modules in the SCADA panel

   d. One power supply module. Allen Bradley 1769-PA4.

   e. One CPU module. Allen Bradley 1769-L32E.

   f. CPU battery. Allen Bradley 1769-BA, lithium battery.

   g. 32-point, 24VDC digital input module. Allen Bradley 1769 IQ32. (Quantity as required by theDrawings)

   h. One 8 channel 4-20mADC analog input module. Allen Bradley 1769 IF8.

   i. Modbus communications module. ProSoft MV169-MCM.

   j. One cable, CPU to SCADA radio.

   k. Two Programming cables, CPU to PC, plus 8 additional spare programming cables Allen Bradley 1756CP3/A

2. Modicon M340 consisting of the following:

   a. Performance

   b. Minimum continuous operating voltage: 150VAC

   c. Minimum continuous feed-through current capacity: 20A

   d. Minimum discharge current: 10kA

   e. Meets UL 1449

   f. Features

      (i) 8 Slot Backplane (BMXXBP0800)

      (ii) Power supply module (BMXCPS3500)

      (iii) CPU (BMXP342020)

      (iv) 32-channel digital input module (BMXDDI3202K), quantity as required by the contract drawings.

(v) 8-channel analog input module (BMXAMIO810)

(vi) Analog input telefast base (ABE-7CPA31E)

(vii) Analog output telefast base (ABE-7CPA21)

(viii) Digital I/O telefast base (ABE-7H16R21)

(ix) Digital telefast connection cable (BMXFCC303)

(x) Empty slot protection cover (pkg. of 5) (BMXXEM010)

(xi) USB Grounded Programming Cable (BMXXCAUSBH045)

(xii) 8 slot shielding connection kit (BMXXSP0800)

D. Communications

1. Allen Bradley:

   a. Modbus communication shall be provided with the use of ProSoft Technology Inc. MVI69-MCM module. The module shall interconnect via RS232 cable.

2. Modicon M340:

   a. Modbus RS232 communication ports shall be provided using the PLC CPU serial ports.

E. Programming:

1. The PLC shall use the latest version of RSLOGIX 5000 Full Edition ENE Configuration software for programming the CPU. Contractor to provide cable needed for communications. (Allen Bradley)

2. The PLC shall use the latest version of the Unity Pro PLC XL Configuration Software for programming the CPU. (Modicon M340)

3. CONTRACTOR to coordinate with SAWS Inspections personnel.

4. All programming will be provided by SAWS personnel.

F. Spare Parts

1. Provide 20% of all installed parts as spares

2. Spares are required for the processor, power supply, and I/O modules.

G. Coordination

1. CPU programming/delivery shall be coordinated with SAWS inspections.

2.14 TRANSIENT SURGE SUPPRESORS

A. Performance

1. Minimum continuous operating voltage: 150VAC.

2. Minimum continuous feed-through current capacity: 20A

3. Minimum discharge current: 10kA

4. Meets UL 1449

B. Features

1. Feed-through design; failure of protection elements shall not interrupt power to protected equipment

2. Modular construction allowing replacement of protection elements without disrupting power to protected equipment

3. DIN rail mountable

C. Acceptable Manufacturers

1. Phoenix Contact COMBOTRAB 28 56 70 2

2. Engineer approved equal

2.15 ANALOG SIGNAL LOOP ISOLATORS

A. Performance

1. Accuracy: +/-0.075% of span

2. Stability: +/-0.2% of reading per year

3. Isolation: 500Vrms between input and output

B. Features

1. Output loop powered

2. DIN rail mountable

C. Acceptable Manufacturers

1. Moore Industries ECT-DIN

2. Engineer approved equal

2.16 ALARM BEACON AND HORN

A. Features

1. Weatherproof construction

2. Flashing red beacon

3. Volume adjustable horn

B. Acceptable Manufacturers

1. Horn- Edwards 876/877 Series
2. Beacon- 114ST series
3. Engineer approved equal

2.17 UNINTERRUPTIBLE POWER SUPPLY

A. Performance

1. 4 msec. transfer time on power failure
2. Sized to the connected load with 25% spare capacity
3. Provide continuous operation for 120 minutes at full load

B. Acceptable Manufacturers

1. Powerware 5115 750 USB with battery failure alarm contact for connection to SCADA RTU.
2. Engineer approved equal.

2.18 ELECTRICAL CONNECTIONS AND WIRING

A. Cables-D.C. Systems

1. Single pair cable shall be 18 gauge, stranded copper, twisted and shielded, equal to Belden 8719.
2. All field cables shall be tagged with T&B E-Z code wire markers, series DPWC or equal. All spare pairs in field cables shall be grounded to the instrumentation ground to eliminate the antenna effect from ungrounded spares.
3. Branch cables shall be run to each instrument in conduit. They shall be connected to instruments according to the instrument manufacturer's recommendation.
4. All instrument signal wiring shall use black insulation as positive (+) and white insulation as negative (-).

2.19 GROUNDING AND SHIELDING.

A. Grounding and shielding shall be a major consideration in the installation of process control electronic instrumentation. Grounding and shielding details shall be designed and incorporated in every instrumentation and electrical engineering work over package.

1. An isolated instrumentation ground (SPG) shall be utilized as the grounding configurations for the electronic instrumentation. The SPG shall be the master reference ground (MRG).
2. Proper bonding procedure shall be followed on every ground connection.
3. A milliamp control loop shall be grounded only at one point, the negative of the power supply.
4. Care must be exercised to avoid multiple commons and multiple grounds when interconnecting different loops with nonisolated instrumentation.
5. Grounded sensors shall have shields grounded on the sensor end only.

6. Ungrounded sensors shall have shields grounded on the receiver end only.

PART 3- EXECUTION

3.01 INSTALLATION

A. Furnish and install all instrumentation and controls and associated equipment as shown on the drawings or as otherwise required for a satisfactorily operating system. Comply with manufacturer's instructions and recommendations.

B. Installation shall be performed by qualified personnel regularly engaged in the installation, checkout, testing and maintenance of industrial process instrumentation and controls systems.

C. Furnish and install all mounting supports, hardware, process seals, isolation devices and fasteners as required for a complete and functional operation.

D. Furnish and install conduit, raceway, wiring, terminations, wire tags, signal isolators, connectors and miscellaneous hardware as required for connection of all signals, shields, power and grounding per this specification.

E. Install power wiring in separate raceways from signal wiring in order to minimize noise induction in process signals. Provide adequate separation between power and signal conduits in ductbanks.

F. Seal all wiring terminations to protect against infiltration of process fluids, moisture, grit, sludge, dust or other contaminants.

G. Install seals on all conduits from wetwell terminal boxes to the SCADA and pump control panels.

3.02 INSTALLATION CHECKS

A. Secure the services of an experienced, competent, manufacturer-authorized representative to visit the site and inspect, check, adjust and approve the installation of the system. Each representative shall be present during the initial startup and at other times as required to resolve any operational issues that may arise.

B. Provide written documentation certifying that all instrumentation and controls equipment is:

1. Properly installed and wired

2. Accurately configured, calibrated, oriented, and aligned

3. Properly placed in service and functioning as designed

C. No separate payment shall be made for installation checks. Time spent during installation checks does not qualify as O&M training where specified.

3.03 FIELD QUALITY CONTROL

A. Furnish equipment manufacturer services as required by the individual equipment specifications.

B. Inspect wiring and connections for physical damage and proper connection.

C. After inspection and prior to energizing equipment, perform and document comprehensive loop checks to ensure proper wiring and continuity between all system components.

D. Provide legible, "red-lined", as-built documentation for all process connections and wiring immediately upon commissioning instrumentation and controls equipment.

3.04 DEMONSTRATION

A. Provide appropriate support personnel for demonstration of operation of completed instrumentation and control system installation during system testing. Instrumentation and controls testing shall be coordinated with the test schedule for other major equipment.

B. Support personnel shall make any required adjustments and changes to instrumentation and controls equipment mounting, wiring, calibration, setup, or configuration to expedite completion of system testing.

C. Provide report documenting test procedures, results, changes, and adjustments required to complete instrumentation and control system testing and demonstration.

PART 4- MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

A. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this item will not be measured or paid for directly, but shall be considered subsidiary to the various bid items of the contract.

END OF SECTION 16901

SECTION 16902

CONTROL PANELS

PART 1- GENERAL

1.01 SCOPE OF WORK

A. The work performed under this Section consists of providing all labor, material, tools, equipment and related items required to furnish and install a SCADA Panel at each site and Pump Control Panels at the locations indicated.

B. Comply with the requirements of the Sections 16900s.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 16010 “Electrical General Information”

B. Section 16120 “Wire and Cable”

C. Section 16450 “Grounding”

D. Section 16901 “Instrumentation and Controls”

E. Section 16904 “SCADA Radio System”

1.03 REFERENCE STANDARDS

A. NEMA

B. UL 508

C. NEC

D. ISA

E. JIC EGP-1

1.04 SUBMITTALS

A. Make all submittals in conformance with Section 01300.

B. Include the following:

1. Scale drawings showing the location of face-of-panel mounted devices. Include a legend listing and identifying the face-of-panel devices by their assigned tag numbers, nameplate inscriptions, service legends and annunciator inscriptions.

2. A listing of devices mounted within the panel. Include the tag number, description, manufacturer and complete model number for each device.

3. Panel elementary diagrams similar to and developed from the drawings Add switched analog signals, panel power distribution, and ancillary devices such as relays, alarms, fuses, lights, fans, heaters, etc. Show circuits and components individually. Show panel terminal and wire identification numbers. Do not submit typical diagrams for multiple circuits.

4. Plumbing diagrams of preplumbed panels and interconnecting plumbing diagrams.

5. Color schedule with color samples and paint chips for the control panels and consoles.

6. Power requirement and heat dissipation summary for all panels. State required voltages, currents, and phase(s). State maximum heat dissipation in Btu/hr.

7. Air conditioner sizing calculations.

8. Data sheets, which contain specific features such as ranges and options.

9. A device list (bill of materials), grouped by device type, for each panel. Include the complete manufacturer's part number, including option designations.

10. Cut sheets and catalog information for pre-manufactured enclosures. Indicate options to be supplied.

11. Fabrication drawings for custom enclosures.

12. Certified factory test reports.

13. Point to point wiring diagrams.

14. Loop diagrams.

1.05 MAINTENANCE

A. Provide the following spare parts:

1. One relay for every 10 relays or fraction thereof. Furnish a minimum of one spare for each type of relay.

2. Other replacement parts as recommended by the manufacturer.

3. Polyphaser.

4. Surge arrestor.

5. Terminal blocks (25% minimum of each type).

B. Provide the following special tools:

1. Lamp puller and installer.

2. Mounting ring wrench(s) for pushbuttons switches and lights.

3. Relay checkout tool to hold relay in operated position.

C. Provide the following expendables:

1. One light bulb for every 10 light bulbs or fraction thereof for each type of bulb supplied.

2. One spare fuse for each 5 fuses of any type installed. Furnish a minimum of one fuse of each type.

1.06 OPERATION AND MAINTENANCE MANUALS

A. Submit Operation and Maintenance Manuals in accordance with Section Section 01730.

PART 2- PRODUCTS

2.01 GENERAL

A. The panels shall comply with the following.

B. Each panel shall contain the items shown on the drawings. These items shall be as specified herein and as specified in Section 16901.

2.02 ENCLOSURES

A. Panels are to be constructed to the approximate dimensions and instrument arrangement as shown on the Plans. Submit alternate arrangements and recommendations to the Engineer for review.

B. All instruments, devices and wiring are to be arranged such that everything can be installed, removed and serviced through the door.

C. Wire entering the panels is to enter via conduits with water tight bushings. All wiring is to be terminated on terminals located on an interior panel prior to being connected to any instrument or switch.

D. The interior of each panel is to be painted white and the exterior color is to be selected by the OWNER from paint samples furnished by the manufacturer.

E. Each panel is to be equipped with a print pocket for storing applicable drawings.

F. Panel doors are to have heavy gauge continuous hinges. Hinges and doors are to be capable of supporting weight of equipment mounted on doors.

G. Mounting channels, swing panels and interior panels are to be provided in the cabinets for mounting pushbuttons, indicating lights, meters, instruments, terminals, relays, etc.

H. The panel is to be completely assembled and wired at the factory such that installation can be accomplished by connecting field wiring to terminal strips located on a lower portion of the interior panel.

I. Panels located outdoors are to be NEMA 4X 316 Stainless Steel. Indoor panels shall be pre-painted. Outdoor stainless steel panels shall not be painted.

J. Outdoor panels shall be dead front construction with nothing mounted on the outside doors. Pilot lights, switches, pushbuttons, elapsed time meters and breaker handles shall be mounted on an interior swing out panel.

K. Panels are to be constructed from minimum 14-gauge steel. Seams are to be continuously welded with no holes or knockouts. Doors are to have rolled lip around three sides and are to be equipped with a hasp and staple for padlocking. Doors on outdoor enclosures are to have continuous hinges and three point latch and locking handle. All doors are to have an oil resistant gasket.

L. A full size steel back panel is to be provided inside each enclosure. Relays, terminal blocks, etc., are to be mounted on the back panel. Enclosures located indoors are to be Hoffman Proline Series, or equal. Outdoor enclosures are to be Hoffman Nema 4X, 316SS, or equal.

M. Cut, punch or drill cutouts for face-of-panel mounted instruments and smoothly finish with rounded edges.

N. Provide steel stiffeners on the back of the panel face as may be required to prevent deflection due to instruments, operation of equipment, or opening/closing of doors. Use 0.25 inch high by 1 inch wide by 0.5-inch deep minimum stiffeners and tack welded to the panel.

O. Provide internal condensation and freezing protection with thermostatically controlled heater on outdoor enclosures. Thermostat adjustable between 40o F to 80o F.

P. Provide a print pocket within enclosures.

Q. Furnish outdoor enclosures with vapor phase protective corrosion inhibitors equal to Hoffman A-HCI-5E or -10E. Activate inhibitor upon delivery of the panel to the site. Do not store panels with inhibitors inactive.

R. Each panel is to contain a weatherproof duplex receptacle (1P, 20A, 120V, 3W polarized), ground fault interrupter (GFIR) type.

S. Provide all cabinets over 18" wide with a fluorescent light having a wire guard. Provide complete with limit switch to activate light when door is opened. Light is to be Hoffman Cat. No. A-LTDA1, or equal.

T. Furnish SCADA panels with thermostatically controlled air conditioning units, McLean, or approved equal, Air conditioned shall circulate air inside the control panel (closed loop) and shall not bring in outside air.

U. Furnish Pump control panels equipped with reduce voltage soft starter with thermostatically controlled air conditioning units, McLean, or approved equal, Air conditioned shall circulate air inside the control panel (closed loop) and shall not bring in outside air.

V. Furnish SCADA panels with a transmitter that will transmit a 4-20ma signal proportional to the inside cabinet temperature to the PLC. Transmitter shall be Weed Instruments #753-PB-X1.

W. Furnish outdoor cabinets with a door stop assembly to hold the door 90 degree open when required.

2.03 CONTROL COMPONENTS

A. Pushbuttons, selector switches and pilot lights are to as specified in Section 16901.

B. Legend Plates: Manufacturer's standard with lettering indicated on the Plans. To be of the same manufacture as the respective pushbutton, selector switch or pilot light.

C. Control Relays: Refer to Section 16901.

D. Timing Relays: Refer to Section 16901

E. Circuit Breakers: Refer to Section 16901.

F. Power Supply: Refer to Section 16901.

G. PLC: Refer to Section 16901

H. Full Voltage Motor Starters: Full voltage motor starters shall be Square D, or approved equal, Nema rated FVNR type with HMCP disconnects and solid state overload units equal to Square D Motor Logic Plus, or Engineer approved equal.

I. Reduced Voltage Motor Starters: Reduced voltage motor starters shall be solid state soft start with bypass contactors. Starters shall be rated for severe duty and shall have pump control features to allow for ramped starting and stopping. Starters shall be Benshaw, or Engineer approved equal.

2.04 WIRING

A. General Wiring: Use #14 AWG, 19 strand copper with Type MTW insulation.

B. Flexible Wiring: Use #14 AWG, 41 strand copper Type SIS for wiring from terminal blocks to 120 VAC devices located on cabinet doors, i.e., pushbuttons, selector switches, pilot lights and annunciator. Leave sufficient slack to allow for full opening of cabinet door.

C. Instrument Wiring: Twisted pair, #16 AWG, stranded copper. Dekoron No. 1852, or equal. Ground shield only at terminal board. Leave sufficient slack for full opening of door.

D. Segregate dc signal wiring from ac control wiring, group functionally and arrange neatly to facilitate tracing of circuits.

E. Use Panduit, or equal, wiring ducts where possible, and provide a minimum of 20 percent spare space. Run ac and dc in separate ducts.

F. Use plastic wiring wraps to bundle wires outside of ducts. Secure to panel steel at maximum 12-inch intervals. Bundle ac and dc separately.

G. Provide Brady, or equal, wire markers to identify each wire at both the terminal block and the device, i.e., at both ends.

H. Color code as follows:

1. Line and load circuits ac or dc power - Black
2. AC control circuits - Red
3. DC control circuits - (+)Blue; (-) White with Blue Stripe.
4. Interlock control circuits on the panel energized from an external source - Yellow
5. Equipment grounding conductors - Green
6. Neutral conductor - White

I. Terminal Blocks:

1. Factory assembled on a Din rail or suitable mounting channel.
2. Provide a minimum of 25 percent spare terminals on each strip. In addition, provide terminal blocks for terminating spare wires being installed on this project.
3. Continuous marking strip.
4. Separate terminal for each shield wire.

5. Reserve one side of each strip for incoming field wiring. Do not make common connections and jumpers required for internal wiring on the field side of the terminal.

6. Do not terminate more than two wires under any one terminal.

7. Provide separate terminal blocks for ac and dc wiring respectively.

8. Space terminal block strips no closer than 4 inches center to center.

9. Control terminal blocks shall be Phoenix Contact Type UK5, or approved equal.

10. Fused terminal blocks shall be Phoenix Contact Type UK6, 3-HESI, or approved equal.

11. Power terminal blocks shall be Square D Class 9080, Type K, or approved equal.

12. Power fuse blocks shall be Square D Class 9080, Type FB, or approved equal.

13. Power distribution blocks shall be Square D Class 9080, Type LB, or approved equal.

J. Grounding:

1. Provide one ground bus for signal grounds and one for equipment grounds.

2. Provide each bus with grounding lugs for connection to the external grounding system.

3. Overload: 15% for 2 minutes.

4. Waveform: Step sine wave with count peak and RMS.

5. Frequency: 60 Hz., +/-0.6 Hz.

2.05 SURGE PROTECTION

A. Refer to Section 16901 and 16289.

2.06 INSTRUMENT AND CONTROL PANEL IDENTIFICATION

A. All devices on the panel are to be permanently identified. The device designations are to agree with those shown on the drawings. Each device is to be provided with permanent type identifying nameplate. Nameplates, unless specified otherwise, are to be approximately one inch by four inches, constructed of black and white laminated phenolic material having engraved letters approximately 1/4 inch high extending through the black face into the white layer. Nameplates, where specified, may be omitted if nameplate description of approximately the same dimension is more convenient and suitable located on the instrument door or face. Nameplates located on the panel face are to be secured with two brass screws. Nameplates, which are mounted on the outside of an enclosure, exposed to weather, are to be adhesive backed type.

2.07 OPERATION AND MAINTENANCE MANUALS

A. Provide six (6) copies of operation and maintenance manuals containing the following information:

1. Wiring diagrams, complete point to point and documented.

2. Panel face layout to scale.

3. Interior layout to scale.

4. Operation and maintenance instructions on the instruments supplied with the panel.

PART 3- EXECUTION

3.01 SHIPMENT AND STORAGE

A. Cabinets are to be prepared for shipment in weatherproof and crush-proof containers.

B. Handling of cabinets is to be accomplished with extreme care, especially after removal from shipping containers.

C. Cabinets to be stored in covered storage protected from the weather, dust and possible damage when handling other equipment.

3.02 TESTING

A. Cabinet wiring shall be factory tested prior to shipment to the site. A test certification shall be furnished with the cabinet and as part of the submittal data.

B. Factory testing shall be witnessed by the Owner and the Engineer if they so elect.

3.03 INSTALLATION

A. Cabinets are to be installed in the locations shown on the Plans.

B. All wiring is to be connected as shown on Plans and all systems are to be thoroughly checked out.

PART 4- MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

A. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this item will not be measured or paid for directly, but shall be considered subsidiary to the various bid items of the contract.

END OF SECTION 16902

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SECTION 16904

SCADA RADIO SYSTEM

PART 1- GENERAL

1.01 SCOPE

A. This Section describes the radio system that is to be furnished as part of the SCADA system at the lift station sites.

1.02 RELATED DOCUMENTS

A. Division 1

B. Section 16010 – General Electrical Requirements

C. Section 16901 – Instrumentation and Controls Systems

D. Section 16902 – Control Panels

E. Section 16951 – Testing Instrumentation and Controls

1.03 SUMMARY

This Section includes the following:

A. Unlicensed 900MHz MAS Radios

B. Antennas

C. Coaxial cable

D. Ancillary radio system components - cable hangers, surge suppression, lightning protection, grounding, power supplies

E. Towers

1.04 LIFT STATIONS

A. The radio system shall consist of a MDS TransNET 900 radio; 10dB gain Yagi antenna, power supply, grounding, and all necessary mounting hardware.

B. The radio shall be mounted in the SCADA RTU cabinet per the drawings.

C. The radio shall connect to the control equipment using a DB-9 connector.

D. The antenna shall be installed on a new self-supporting tower or pole installed within the lift station fence per the drawings. The antenna shall be aligned at the azimuth indicated in the plans towards the indicated hub site or repeater site.

E. LMR-400 low loss coaxial cable shall interconnect the radio and antenna, and shall be routed per the drawings. LMR-400 to be used for antenna cable length up to 50-ft. If greater than 50-ft, use 7/8" Heliax cable.

F. The antenna shall be properly grounded.

1.05 REPEATER STATIONS

A. One or more repeater station(s) may be required to provide additional path connectivity to the designated lift stations, if identified on the System Layout Sheet.

B. At the repeater stations the radio system will consist of one (1) MDS TransNET 900 radio, one (1) 9dB gain omnidirectional antenna, transmission line, power supplies, grounding, and all necessary mounting hardware.

C. The radios shall be mounted in the appropriate cabinet(s) as identified on the drawings.

D. The radio will operate in a store-and-forward repeater mode. Each radio has a DB-9 connector for data connections.

E. The omnidirectional antenna shall be installed at the repeater site(s) as identified on the drawings.

F. Low loss 7/8" coaxial cable shall interconnect the radios and antennas, and shall be routed per the drawings. Short LMR-400 jumpers of 50-ft or less may be used to facilitate access to radios and antennas.

G. The antennas shall be properly grounded.

1.06 SUBMITTALS

A. Product Data shall be submitted for each type of product indicated per instructions in Division 1.

1.07 QUALITY ASSURANCE

A. All materials and accessories, whether specifically described or not, shall be of the best grade of commercial manufacturer and all workmanship shall be first class in every respect.

B. All electronic equipment shall be of the manufacture and model number as specified herein. No substitution of equipment may be made under any circumstances.

C. All equipment provided shall be mounted as shown on the project plans. All equipment and cable installations shall be made in a professional and workmanlike manner, in accordance with industry practices and procedures, the equipment manufacturer's recommended procedures, and standard electrical equipment installation practices.

D. This installation shall be made in accordance with the latest requirements of the National Electrical Code, ANSI/NFPA-70.

E. In the event of any apparent conflict of quantities, standards, codes, or this specification, CONTRACTOR shall submit an RFI to the OWNER and ENGINEER for written resolution.

1.08 COORDINATION

A. Coordinate installation of lift station radio equipment with placement of enclosure for SCADA RTU and adjacent pole, per the plans.

B. Coordinate testing of radio system with SCADA system so that equipment and all other systems that are functionally interdependent are tested as a unit to demonstrate successful end-to-end interoperability of all systems.

PART 2- PRODUCTS

2.01 MANUFACTURERS

A. The SAWS Lift Station radio system has been designed, and this specification has been developed, using the performance characteristics of GE MDS Transnet 900 Spread Spectrum unlicensed 900 MHz radios.

B. Substitute equipment may NOT be proposed, due to the requirement for compatibility with existing radio equipment spare parts.

2.02 OVERALL SYSTEM

A. CONTRACTOR is responsible for verifying all existing conditions and path clearances.

2.03 UNLICENSED RADIO SYSTEMS

A. All microwave system equipment procured under this acquisition document shall be FCC type accepted and shall have been specifically designed to provide two-way transmission of packet data.

B. The radios manufacturer must be certified as an ISO 9001 approved facility. A certificate of ISO 9001 registration must be included with the bid documents.

C. Spread spectrum radios supplied under this contract must meet FCC rules for unlicensed radio operation in the 902-928 MHz band.

D. The radio shall be UL recognized for Class I, Division 2, Groups A, B, C, D hazardous locations when installed in an approved enclosure.

E. The radios shall be capable of transmitting data at a variety of user-selectable rates between 1200 and 115,200 bits per second effective throughput. The radio shall provide an RS/EIA-232 interface.

F. The radio must be capable of buffering data to eliminate gaps in messages for protocols that cannot tolerate gaps.

G. Each radio shall be furnished with a dedicated power supply.

2.04 TRANSMISSION CABLE & MISCELLANEOUS RADIO EQUIPMENT

A. At lift stations, provide flexible cable connecting the radio antenna port with the antenna that is flexible low-loss foam-dielectric type, 0.4 in. diameter. Provide for cable length of less than 50-ft Times Microwave LMR-400-PVC or equivalent. Cable shall be placed as shown on the drawings.

B. At repeater locations, provide low-loss foam-dielectric type cable, 7/8 in diameter. Provide Andrew Corp LDF5-50A or equivalent. Cable shall be placed as shown on the drawings.

C. Where appropriate, provide flexible cable connecting the radio antenna port with the 7/8 in. cables that is flexible low-loss foam-dielectric type, 0.4 in. diameter. For cable length of less than 50-ft provide Times Microwave LMR-400-PVC or equivalent. Cable shall be placed as shown on the drawings.

D. Where appropriate, provide a short section of "superflexible" transmission cable at the radio antenna port. Provide standard Type N connectors for connection to a continuous piece of cable extending to the antenna.

E. Provide weatherproof transmission cable, suitable for direct environmental exposure. Use "O" ring seals on connections.

F. Provide all required connectors to interface cable to equipment on each end. Provide Times Microwave or equivalent to match cable.

G. Coaxial lines to antennas shall be enclosed in conduit to protect against vandalism. Underground access enclosures for cable splicing are being installed as indicated on the drawings.

H. Provide all required hangers, ground kits, and lightning arrestors, etc.

2.05 SPARE PARTS

A. Vendor must include a complete itemized list of radio system spare parts. Bids shall include pricing for providing 20% of all installed parts as spares.

2.06 TEST EQUIPMENT

A. Vendor must include a complete list of all test equipment, and interface equipment for maintenance and diagnostic testing.

2.07 DIRECTIONAL YAGI ANTENNA

A. Directional antennas must meet the following requirements:

1. Frequency range: 890 to 960 MHz, or as required
2. Gain: 10 dBd, or as required
3. Maximum Power Input: 150 watts
4. Lightning Protection: Direct ground protection to mast
5. Front-to-Back Ratio: 20 dBd, minimum
6. Connector: Type N, female
7. VSWR: Less than 1.5:1

B. Mounting Hardware: Weatherproof clamp for direct mount to 2 inch, Schedule 40 steel pipe

C. Acceptable Products:

1. SCALA TY-915N
2. Engineer approved equivalent.

2.08 OMNIDIRECTIONAL REPEATER ANTENNA

A. Omnidirectional antennas must meet the following requirements:

1. Frequency range: 890 to 960 MHz, or as required
2. Gain: 9 dBd, or as required
3. Maximum Power Input: 500 watts

4. Connector: Type N, female

5. VSWR: Less than 1.5:1

B. Mounting Hardware: Weatherproof clamp for direct mount to 2 inch, Schedule 40 steel pipe

C. Acceptable Products:

1. SCALA OGB9-900 or 915 NIS

2. Engineer approved equivalent.

2.09 SELF-SUPPORTING TOWER

A. Self-supporting towers for lift station and repeater antennas must meet the following requirements:

1. Tower must be designed in accordance with ANSI/EIA-222-F or later.

2. Tower must be designed for 90 mph wind without ice and 70 mph wind with ½" ice as required for Bexar County.

3. Tower must have fixed base per manufacturer's specification. Pinned bases are not allowed.

4. Tower must be sized for the total planned antenna wind loading.

5. Tower must be self-supporting at the required height and antenna loading according to the manufacturer's specification.

6. Tower sections must be hot-dipped galvanized following manufacture and any modifications.

B. Hardware

1. All assembly and mounting hardware must be galvanized or stainless steel.

C. Acceptable Products

1. Rohn 55G up to 40' with single Yagi antenna.

2. Rohn 55G up to 45' with single omnidirectional antenna.

3. Optional installation of an additional 10ft straight section and top mounting bracket 55TDM253KD in lieu of 9ft tapered top section is acceptable.

4. Engineer approved equivalent.

2.10 THE CONTRACTOR SHALL PROVIDE ALL MASTS, LIGHTNING ARRESTORS, AND OTHER APPARATUS REQUIRED TO MAKE A COMPLETE AND OPERABLE RF RADIO SYSTEM.

PART 3- EXECUTION

3.01 INSTALLATION REQUIREMENTS

A. CONTRACTOR shall provide and pay for all labor, materials, equipment, tools, utilities, and . services necessary for the proper execution and completion of the installation of each of the above specified systems.

B. CONTRACTOR shall coordinate with OWNER's representative to insure that any interference or interruptions of operations are anticipated and scheduled. Construction may be observed by the OWNER or ENGINEER.

C. CONTRACTOR shall complete and submit accurate record drawings within 30 days from completion of construction, indicating any variations from original design and all other pertinent information.

3.02 INSTALLATION METHODS

A. CONTRACTOR shall provide and install equipment as indicated on the contract drawings, as recommended by the manufacturer, and as specified herein. Where specific equipment layout and location are detailed it is the CONTRACTOR's responsibility to install all equipment as specified or provide complete information justifying alternatives.

B. CONTRACTOR shall use tools and equipment specifically designed for the purpose. The CONTRACTOR shall implement installation practices that insure the highest quality installation. CONTRACTOR shall make all cutting, splicing, pulling and termination of cables using equipment specifically designed for that purpose.

3.03 SYSTEM PROOF OF PERFORMANCE

A. Upon completion of the installation, it shall be the responsibility of the CONTRACTOR to perform the necessary adjustments and balancing of all signals and level controls to insure proper system operation.

B. Each cable shall be installed with proper termination.

C. Before the contract shall be considered completed, the CONTRACTOR shall conduct an operating test for approval by the ENGINEER and OWNER. The system shall be demonstrated to operate in accordance with the requirements of these specifications. The test shall be performed in the presence of the OWNER or his representative and the ENGINEER. The CONTRACTOR shall provide all equipment and personnel required for the test.

D. Should the demonstration of performance show that the CONTRACTOR has not properly installed the equipment, or that the equipment installed is of faulty manufacture or assembly, or that the installed system does not provide the required video origination, switching, control, and monitoring capabilities, the CONTRACTOR agrees to correct all system deficiencies and redemonstrate until the system functions properly at no cost to the OWNER.

E. Each radio system must be tested to validate RF strength at the site from the hub control site. A minimum of -86dBm signal level must be available at each lift station.

3.04 WARRANTY

A. The CONTRACTOR shall warrant the system in its entirety for a period of two (2) years from date of Final acceptance to meet all performance requirements outlined herein, provided all routine maintenance is performed as scheduled.

B. No charges shall be made by the CONTRACTOR for any labor, equipment or transportation during this period to maintain functions. However, the CONTRACTOR shall not be held responsible for damage resulting from vandalism or acts of God.

C. Due to the nature of the intended use of the system, the CONTRACTOR shall respond to a trouble call within twenty-four (24) hours after receipt of call within warranty period.

3.05 OPERATION AND MAINTENANCE MANUALS

A. After completion of the installation and proof of system performance has taken place, the CONTRACTOR shall furnish six (6) sets of operating instructions including circuit diagrams and other information necessary for proper installation, operation and maintenance of all system components.

3.06 RECORD DRAWINGS

A. Record drawings shall be supplied by the CONTRACTOR. These drawings shall include signal levels and test results at key test points throughout the system as measured on the date of final acceptance.

B. All test data recorded during the system proof of performance testing shall be included in the record drawing set to be supplied to the OWNER.

3.07 GUARANTEE

A. The system shall be guaranteed to be free from all defects of material and workmanship for a period of two (2) years effective upon date of Final acceptance. Equipment or components showing inherent defects of a mechanical or electrical nature shall be replaced promptly at no expense to the OWNER.

PART 4- MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

A. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this item will not be measured or paid for directly, but shall be considered subsidiary to the various bid items of the contract.

END OF SECTION 16904

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SECTION 16940

INSTRUMENTATION HEAT TRACE SYSTEM

PART 1- GENERAL

1.01 DESCRIPTION OF WORK

A. Furnish and install thermostatically controlled heat trace system for freeze protection.

B. The system shall include controls, control cabinet, cable, insulation, and jacket as indicated on the Contract Drawings and as specified hereinafter.

C. Furnish and install all weather-tight LB fittings, liquid-tight connectors, liquid-tight flexible metal conduit and wiring, etc., to provide power and controls for a complete operating system.

D. Items to be protected by heat trace include:

1. Instrument fluid housing and all associated piping, valves, fittings, etc.

1.02 SUBMITTALS

A. Heat trace cable.

B. Heat trace cable insulation and jacket.

C. Heat trace thermostat.

D. Heat trace panel wiring.

PART 2- PRODUCTS

2.01 HEAT TRACE CABLE

A. Heat trace cable shall be U.L. listed, self-regulating, with additional footage at all valves, instruments, and pipe supports, as recommended by the manufacturer. Maximum circuit lengths shall be in accordance with manufacturer's recommendations.

B. Manufacturer: Heat cable shall be Raychem "5BTV1", 6 watts/ft at 40°F for operation at 120 volts, or equal product as manufactured by Chromalox or Thermon.

2.02 HEAT TRACE INSULATION AND JACKET

A. The insulation shall be performed cellular glass insulation, 1" thick minimum, non-absorptive, impermeable to moisture and impervious to hydrochloric acid.

B. A weather-resistant, water-tight, protective finish or jacket shall be applied over all insulation as recommended and manufactured by the insulation manufacturer.

C. Manufacturer: Heat trace insulation shall be Pittsburg Corning "Foamglas", Armstrong Armaflex II pipe insulation, or engineer approved equal.

2.03 HEAT TRACE THERMOSTAT (HTT) AND CONTACTOR (HTC)

A. Heat trace circuits shall be switched through a thermostat set at 40°F. The contactor shall be 20 ampere, 120 volts, multipole, with 120-volt control coil. The thermostat shall be weatherproof, line-type, 120 volts.

B. Manufacturer: Heat trace thermostat shall be Thermon model B4X.

PART 3- EXECUTION

3.01 HEAT TRACE CABLE

A. Spiral the heat cable around the pipe, and around valves per manufacturer recommendation, and attach cable to pipe with GT-66 glass fiber adhesive tape or plastic tie wraps.

B. All power connections to heat trace cable shall be made in watertight j-boxes or with power connection kits recommended by the cable manufacturer. Tees, splices, terminations, and cable shall be of the same manufacturer.

3.02 HEAT TRACE CABLE INSULATION

A. Install insulation over the entire length of piping protected with heat cable. Insulation shall be mitered and nested to cover all tees, fittings, supports, valves, etc. Fitting covers may be preformed or field fabricated. The inner bore and joint surfaced shall be coated to fill the surface cells, and all joints shall be sealed as recommended by the manufacturer and secured in place with ½" wide stainless steel bands.

END OF SECTION 16940

SECTION 16951

TESTING INSTRUMENTATION AND CONTROLS

PART 1- GENERAL

1.01 SUMMARY

A. This Section describes field testing requirements including the manner in which the testing is to take place. The CONTRACTOR shall coordinate all instrumentation and control requirements with SAWS. Refer to other applicable Sections of this Specification for testing and calibration requirements of individual instrument and control devices.

B. Testing shall be performed by an independent testing concern approved by the Owner.

1.02 SUBMITTALS

A. The following information shall be included in the submittal for this Section:

1. Loop checkout schedule.

2. Loop checkout procedures including sign-off forms.

3. Schedules, procedures and sign-off forms for all other tests specified.

B. Within two weeks following completion of any field tests, test report/documentation shall be submitted to the ENGINEER.

1.03 GENERAL

A. Extensive field testing shall be performed to verify the operation of the entire system.

B. Field testing shall be sequential in nature and shall be organized by site.

C. Site testing shall include loop checkout, testing RTU additions, and maintenance/support demonstrations.

D. An integrated system test shall be performed to verify the operation of all additions to the existing system.

E. Record results on the Loop Checkout sheets. Checkout sheets shall be prepared by the CONTRACTOR and submitted to the ENGINEER for approval.

PART 2- PRODUCTS (NOT USED)

PART 3- EXECUTION

3.01 SITE TESTING

A. Loops

1. Loop tests shall include the following:

a. Pump high temperature.

b. Pump seal leak.

c. Pump control.

d. Wetwell level transmitter.

e. High level float switch.

f. Station power failure.

g. Generator operation.

h. Generator trouble.

i. Automatic transfer switch operation.

j. Transfer failure

k. Discharge pressure.

l. SSRV failure.

2. Each loop shall be tested from the element, i.e., switch, transmitter or relay, to the starter, control panel to the RTU, as applicable.

3. All loop checks shall be documented and submitted to the ENGINEER. Documentation shall include:

   a. Loop name.

   b. Loop description.

   c. Termination information.

   d. Drawing reference.

   e. Type of test(s) performed.

   f. Date tested.

   g. Signature of tester and date.

   h. Signature of OWNER or ENGINEER and date.

   i. Problem description, if any.

4. All loops found to contain defective or inoperable equipment shall be summarized on separate sheets and submitted to the ENGINEER and OWNER.

   a. Work performed under this Contract shall be corrected and rechecked.

   b. Correction of defective work by others shall be coordinated by the OWNER. Rechecking shall be performed as a part of this Contract.

B. Pump Controls

1. Each pump control loop shall be tested individually.

2. An overall pump control loop shall not be tested until the following items have been individually tested:

   a. Wetwell level controller.

   b. Pump alarms.

   c. Backup float switches.

3. Conduct the test for each loop as shown on the attached checkout sheets.

C. Alarm Loops

1. Simulate each alarm condition as realistically as possible.

2. Observe the LED on the applicable RTU input module.

3. Observe the light and audible alarm.

D. Analog (Measurement) Loops

1. Discharge Pressure: With PIT installed, connect pressure source to the input pressure tap of the PIT; simulate pressure input signal to measure 0%, 25%, 50%, 75%, 100% (five-point calibration standard) of calibrated span for the PIT output 4-20 mA signal. Verify loop signal-loop tester and programmer data registers. Compare values with readings of a calibrated gauge in the transmitter location. Record observations on the attached form.

2. Wetwell Level: While filling wetwell observe level readings on the transmitter and on the indicator at low level, pump start and stop levels and high level. Compare these observed levels with actual measurements made with a tape or other measuring device. Record observations on the attached form.

E. RTU

1. Connect a PLC program function block to the communications port of the PLC in the RTU.

2. Call up the appropriate function block diagram on the monitor screen.

3. Observe the power flow on the function block diagram when each alarm condition is simulated. Normally open contacts should close and normally closed ones should open.

3.02 MAINTENANCE OF OPERATIONS

A. Field testing shall be scheduled through SAWS at least 7 days in advance.

B. No testing that may affect operation shall be permitted without SAWS's concurrence.

C. No OWNER involvement or approval testing shall be performed on Thursday or Friday without consent of SAWS.

3.03 TESTING PRECEDENTS

A. The following conditions shall be met prior to the start of any testing:

1. All documentation pertinent to the equipment being tested shall be on-site.

2. All spare parts, expendables and test equipment pertinent to the equipment being tested shall be on- site, labeled and properly stored.

3. All field equipment supplied and pertinent to the equipment being tested shall be operational.

4. Test schedules and test procedures shall have been submitted to and approved by SAWS.

B. All test procedures and test results shall reflect information contained within the various operation and maintenance manuals furnished.

3.04 OWNER INVOLVEMENT

A. SAWS may participate in testing activities at its discretion.

B. SAWS participation and use shall be such that it does not adversely affect specified testing requirements. No claim for delay shall be allowed unless the following conditions are met:

1. SAWS and the ENGINEER are notified verbally that SAWS actions could cause delay if continued.

2. SAWS or the ENGINEER persists in the delay action.

3. Written documentation is submitted to the ENGINEER within 24 hours which describes SAWS action and impact.

PART 4- MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

A. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this item will not be measured or paid for directly, but shall be considered subsidiary to the various bid items of the contract.

SAWS LIFT STATION No. _____
ANALOG PRESSURE
LOOP CHECKOUT SHEET

Loop Name: Discharge Pressure

Service: Wastewater

Transmitter No: PIT 100

RTU Terminal Blocks for Analog Input _____ and _____

PLC Register Value for Analog Input _____

Pressure Generated by Calibrator	Reading on Transmitter	Reading on Indicator at RTU
(0%)		
(25%)		
(50%)		
(75%)		
(100%)		

Note Any Problems in this Space:

Date _____

Tested By _____

Witness _____

SAWS LIFT STATION No. _____
WETWELL LEVEL
LOOP CHECKOUT SHEET

Loop Name: Wetwell Level

Service: Wastewater

Transmitter No: LIT 100

RTU Terminal Blocks for Analog Input _____ and _____

PLC Register Value for Analog Input _____

Wetwell Level	Reading on Transmitter	Reading on Indicator at RTU
Low Level		
Lead Pump On		
Lag Pump On		
**2nd Lag Pump On		
High Level		

**2nd Lag Pump locked out when generator is operating.

Note Any Problems in this Space:

Date _____

Tested By _____

Witness _____