

**Collier County Utilities,
Tamiami Well 18 Generator Replacement**

DIVISION 26 – ELECTRICAL INDEX

26 05 00	Basic Materials and Methods
26 05 11	Special Requirements for Electrical Installations.
26 05 19	Low-Voltage Wires and Cables
26 05 26	Grounding and Bonding for Electrical Systems
26 05 29	Hangers and Supports for Electrical Systems
26 05 51	Conduit Systems
26 32 13	Diesel-Engine-Driven Generator Sets

SECTION 26 05 00
BASIC ELECTRICAL MATERIALS AND METHODS

GENERAL

1.1 SUMMARY

- A. Section Includes: General requirements for providing basic electrical materials and methods and specific work included as follows:
- B. The work required includes all materials, labor and auxiliaries required to install a complete and properly operating electrical system. The electrical system required under this Division consists basically of, but is not limited to the following:
 - 1. Removal & Installation of Standby Diesel Generator Systems
 - 2. Inspection and testing of fuel storage systems.
- C. Related Work Specified in Other Sections Includes: none
- D. Overall Application of Specifications: This Section applies to all sections of Division 16 and to other sections that include electrical equipment requirements except when in these individual sections requirements are otherwise specified to provide and install all materials necessary for a complete operational system.
- E. Temporary Requirements: This Section applies to any temporary circuits, overcurrent devices, conduit, wiring, and other equipment required during changeover from existing to a new electrical system. This Section also applies to temporary rewiring of lighting and power circuits, instruments and devices.
- F. Drawings are diagrammatic. Correlate final equipment locations with governing Architectural, Structural, Process Mechanical and Instrumentation and Control drawings. Lay out before installation so that all trades may install equipment in spaces available. Provide coordination as required for installation in a neat and workmanlike manner. Provide layout shop drawings for engineers review for all MCC and electrical equipment rooms.

1.2 DEFINITIONS

- A. Hazardous Areas: Equipment, materials and installation in areas designated as hazardous on the Drawings shall comply with NEC Articles 500, 501, 502 and 503. Hazardous areas as defined by the NEC as Class I, Division 1, Group D, or Class I, Division 2, Group D; hazardous areas as follows:
 - 1. Class 1, Division 1, Group D
 - a. Wet Wells
 - b. Pretreatment
 - 2. Class 1, Division 2, Group D
 - a. Pump Rooms and Dry Well
 - b. Odor control

1.3 SYSTEM DESCRIPTION

- A. Design Requirements: Design requirements are specified in the applicable sections.
- B. Performance Requirements: Performance requirements are specified in the applicable sections.

1.4 SUBMITTALS

- A. General: Reference Submittals Section 01310: Provide submittals for all electrical material and devices.
- B. Substitutions:
 - 1. Each bidder represents that his bid is based upon the materials and equipment described in this division of the specifications.
 - 2. No substitutions will be considered unless written request has been submitted to the Engineer for approval at least ten days prior to the bid date. Submittal shall include the name of the material or equipment for which it is to be substituted, drawings, cuts, performance and test data and any other data or information necessary for the Engineer to determine that the equipment meets all specification and requirements. If the Engineer approves any proposed substitutions, such approval will be set forth in an addendum.
 - 3. Substituted equipment or optional equipment where permitted and approved, must conform to space requirements. Any substituted equipment that cannot meet space requirements, whether approved or not, shall be replaced at the Contractor's expense. Any modifications of related systems as a result of substitutions shall be made at the Contractor's expense.
- C. Product Data and Information: Provide complete list of electrical equipment and materials to be furnished showing manufacturer, catalog number, size, type, voltage rating and other pertinent information.
 - 1. Provide catalog data on manufacturer's standard equipment and materials. Clearly indicate on catalog cuts the equipment and devices being proposed.
 - 2. Identification: Provide complete schedule and listing of system and equipment identification labels with legends.
 - 3. Material shall not be ordered or shipped until the shop drawings have been approved.
 - 4. The Engineer's shop drawing review shall be for conformance with the design concept of the project and compliance with the Specifications and the Drawings. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by the Specifications and the Drawings.
 - 5. Shop drawings shall be stamped with the date checked by the contractor and a statement indicating that the shop drawings conform the Specifications and the Drawings. This statement shall also list all exceptions to the Specifications and the Drawings. Shop drawings not so checked and noted shall be returned.
 - 6. Provide an adequately sized, hard-cover, 3-ring binder for 8-1/2" X 11" for all submittal sheets. Provide correct designation on outside cover and on end of binder. First sheet in the brochure shall be a photocopy of the Electrical Index pages used as a table of contents and tabbed accordingly. The second tab shall be the electrical cost breakdown "Schedule of Values" for electrical work. Cost of material and labor for each major item shall be shown. Provide reinforced separation sheets tabbed with the appropriate specification reference number.

Provide Technical Information consisting of marked catalog sheets or shop drawings shall be inserted in the brochure in proper order on all items herein specified or shown on drawings.

- D. CONTRACTOR's Shop Drawings: Provide shop drawings on items manufactured for the Contract.
1. Provide connection diagram and schematic for each piece of electrical equipment. A manufacturer's standard connection diagram or schematic showing more than one method of connection is not acceptable unless it is clearly marked to show the intended method of connection.
 2. Provide diagrams showing connections to field equipment. Clearly differentiate between manufacturer's wiring and field wiring.
 3. Provide raceway layout drawings showing conduits, boxes, and panels which contain the conductors to be provided. Include schedules listing conduit sizes and conductor content and identification.
 4. Where additions and modifications are made to existing equipment, provide drawings which include both retained existing equipment and new Work.
- E. Coordination Drawings: Prepare to scale coordination drawings (1/4"=1'-0"); detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Provide detailed shop drawings for all electrical equipment to be supplied. Provide detailed plan view shop drawings at expanded scale indicating how actual size of equipment to be provided is to fit into space available; show NEC required working space clearances on plan. Provide detailed elevation views at expanded scale of actual equipment to be provided and how it fits into available wall spaces. Drawings shall be on 11" X 17" or 22" X 34" paper and drawn with a computer aided design (CAD) package. The computer aided design package shall be Autocad or converted to Autocad format. Engineering plan backgrounds of the facility shown on the contract documents will be available to the contractor on request. Submittals shall include hard copy and CD-ROM media electronic copies. Additional shop drawing requirements: Includes but not necessarily limited to the following:
1. Indicate the proposed locations of major raceway systems, equipment, and materials. All dimensions shall be field verified at the job site and coordinated with the work of all other trades. Include the following:
 - a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
 - b. Exterior wall and foundation penetrations.
 - c. Fire-rated wall and floor penetrations.
 - d. Equipment connections and support details.
 - e. Sizes and location of required concrete pads and bases.
- F. Record Documents: Prepare record documents, and in addition to the requirements specified in Division 1. As the work progresses, legibly record all field changes on a set of Project Contract Drawings, (the "Record Drawings"). indicate installed conditions for:
1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
 2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.

3. Approved substitutions, and actual equipment and materials installed.
 4. Record Drawings shall accurately show the installed condition of the following items: Power Riser Diagram(s). Equipment elevations (front views). Raceways and pullboxes. Conductor sizes and conduit fills. Control Wiring Diagram(s). Underground raceway and duct bank routing. Plan view, sizes and locations of distribution transformers and outdoor electrical equipment enclosure.
 5. Submit a schedule of control wiring raceways and wire numbers, including the following information: Circuit origin, destination and wire numbers. Field wiring terminal strip names and numbers.
 6. In addition to the schedule, provide point to point connection diagrams showing the same information submitted in the schedule of control wiring raceways including all designations and wire numbers. Comply with PLC tag designation on all instrumentation and control cabling in and out of PLC racks.
 7. The schedule of control wiring raceways and wire numbers and the point to point connection diagrams shall be in electronic Autocad and Word format (i.e. no hand-written or drawn schedules, drawings, or diagrams will be accepted)
- G. Operation and Maintenance Manuals: Prepare operation and maintenance manuals, and in addition to the requirements specified in other Divisions, include the following information for equipment items:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and catalog numbers of replacement parts. Complete parts list with stock numbers, including spare parts. A complete bill of material supplied, including serial numbers, ranges and pertinent data.
 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions. The operating instructions shall also incorporate a functional description of the entire system, with references to the systems schematic drawings and instructions.
 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 4. A comprehensive index.
 5. A complete "As Built" set of approved shop drawings.
 6. A table listing of the "as left" settings for all timing relays and alarm and trip setpoints. A complete listing of As left programmable parameters for all drives, soft-starters and other microprocessor controlled equipment.
 7. System schematic drawings "As Built", illustrating all components, piping and electric connections of the systems supplied under this Section.

1.5 QUALITY ASSURANCE

- A. Codes: Provide all electrical Work in accordance with applicable local codes, regulations and ordinances. If there is a conflict between the requirements specified in the Contract Documents and the codes, follow the more stringent requirements as determined and approved.
- B. Testing: As a minimum, provide standard factory and field tests for each type of equipment. Other tests may be specified in the applicable equipment section.

- C. Labeling: Provide all electrical equipment and materials listed and approved by Underwriters Laboratories with the UL label or other OSHA recognized testing laboratories attached to it.
- D. Standard Products: Unless otherwise indicated, provide electrical materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturer's latest standard design that conforms to these Specifications. When two or more units of the same class of material and equipment are required, provide the products of the same manufacturer.

1.6 DELIVERY, STORAGE AND HANDLING

- A. General: Deliver, store and handle all products and materials as specified in Division 1 and as follows:
- B. Shipping and Packing: Provide materials and equipment suitably boxed, crated or otherwise completely enclosed and protected during shipment, handling, and storage. Clearly label such boxes, crates or enclosures with manufacturer's name, and name of material or equipment enclosed.
- C. Acceptance at Site: Conform to acceptance requirements as required in Division 1. Repair or replace all materials and equipment damaged by handling and storage as directed at no additional Contract cost.
- D. Storage and Protection: Protect materials and equipment from exposure to the elements and keep them dry at all times. Handle and store to prevent damage and deterioration in accordance with manufacturer's recommendations.

1.7 PROJECT CONDITIONS

- A. General: The Drawings indicate the extent and general arrangement of the principal electrical elements, outlets and circuit layouts. Connect and install all electrical elements and devices to form a workable system as required by the Contract Documents whether the connections and installations are specifically stated in the Specifications or shown. Provide necessary materials and installation wherever required to conform to the specific requirements of the furnished equipment and for proper installation of the Work.
- B. Schematics: In general the runs of feeders are shown schematically and are not intended to show exact routing and locations of raceways. Verify actual and final arrangement, equipment locations, and prepare circuit and raceway layouts before ordering materials and equipment. Equipment locations are approximate and are subject to modifications as determined by equipment dimensions.
- C. Coordination of Work: Coordinate the Work so that the electrical equipment may be installed without altering building components, other equipment or installations.
- D. Coordinate arrangement, mounting, and support of electrical equipment: To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated. To provide for ease of disconnecting the equipment with minimum interference to other installations. To allow the right of way for piping and conduit installed at the required slope. To clear connecting raceways, cables, wireways, cable trays, and busways of obstructions and of the working and access

space of other equipment. Coordinate the installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed. Coordinate electrical testing of electrical, mechanical, and architectural items, so that functionally interdependent equipment and systems demonstrate successful interoperability.

- E. Departure from Design: If departures are deemed necessary due to structural conditions, obstructions or other problems, provide details of such departures and the reasons for requesting approval as soon as practicable but not later than the submittal of the raceway layout drawings. Do not make any departures without written approval.

PRODUCTS

Not Used

EXECUTION

3.1 ROUGH-IN

- A. Final Location: Verify final locations for rough-ins with field measurements, vendor shop drawings and with the requirements of the actual equipment to be connected.
- B. The Drawings are not intended to show exact locations of conduit runs. Coordinate the conduit installation with other trades and the actual supplied equipment.
- C. Install each 3 phase circuit in a separate conduit unless otherwise shown.
- D. Except where dimensions are shown, the locations of equipment, fixtures, outlets and similar devices shown on the Drawings are approximate only. Exact locations shall be determined by the Contractor and approved by the Engineer during construction. Obtain information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.
- E. Surface mounted panel boxes, junction boxes, conduit, etc., shall be supported by spacers to provide a clearance between wall and equipment.
- F. All floor mounted electrical equipment shall be placed on 4-inch thick (3/4-inch, 45 degree chamfer at all exposed edges) concrete pads, provide reinforcement, anchors, etc.

3.2 ELECTRICAL INSTALLATIONS

- A. Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
 - 1. Coordinate electrical systems, equipment, and materials installation with other building components.
Verify all dimensions by field measurements. Investigate each space in the structure through which equipment must pass to reach its final location.
Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.
 - 2. The equipment shall be kept upright at all times during storage and handling. When equipment must be tilted for passage through restricted areas, brace the equipment to ensure that the tilting does not impair the functional integrity of the equipment.
 - 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.

4. Coordinate the installation of required supporting devices and sleeves to be set in cast-in-place concrete and other structural components, as they are constructed.
5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the ENGINEER for resolution.
9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
10. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
11. Furnish and install reinforced concrete pads for transformers, switchgear, and motor control centers, of size as shown on the drawings or required. Unless otherwise noted, pads shall be four (4) inches high and shall exceed dimensions of equipment being set on them, including future sections, by three (3) inches on all sides, except when equipment is flush against a wall, then the side or sides against the wall shall be flush with the equipment. Chamfer top edges 1". Trowel all surfaces smooth. Reinforce pads with 6" X 6" X 6/6 welded wire fabric. Conduit stub up area within the pad area shall remain void. Coordinate with equipment shop drawings stub up areas.
12. Provide rubber insulation mats on floor in front of electrical equipment extending 18" beyond. Mats to be minimum 3 feet wide or equal to isle width. Provide OSHA approved insulating mats meeting OSHA regulation 1910.137 with 20,000 volt insulating strength. Ranco Industries or equal Phone: (800) 228-5543 Corrugated Switchboard matting. Bottom knurled with certification engraved. ASTM D-178, Type II, Class 1, 20,000VAC Dielectric Test Voltage, Maximum use voltage 7,500VAC.
13. Install access panel or doors where units are concealed behind finished *surfaces*.
14. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.3 CUTTING AND PATCHING

- A. Perform cutting and patching as specified in Division 1. In addition to the requirements specified in Division 1, the following requirements apply:
 1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - a. Uncover Work to provide for installation of ill-timed Work.

- b. Remove and replace defective Work.
 - c. Remove and replace Work not conforming to requirements of the Contract Documents.
 - d. Remove samples of installed Work as specified for testing.
 - e. Install equipment and materials in existing structures.
 - f. Locate existing structural reinforcing where core drilled penetrations are required so as not to cut the steel reinforcing.
2. Cut, remove, and properly dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work. Deliver all the existing removed to the OWNER as directed.
 3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
 4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
 5. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
 6. Patch finished surfaces and building components using new materials as specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

3.4 EXISTING CONDITIONS

- A. Investigate site thoroughly and reroute all conduit and wiring in area of new construction in order to maintain continuity of existing circuitry. Existing conduits shown on plans show approximate locations only. Contractor must verify and coordinate existing site conduits and pipes to any excavation on site. Bids to include hand digging and all required rerouting in areas of existing conduits and/or pipes. Special attention is called to the fact that work involved is in connection with existing facilities that must remain in operation while work is being performed. Work must be done in accordance with the owner's priority schedule as required. Schedule work for a minimum outage to Owner. Request written permission and receive written approval from Owner 48 hours in advance of any shutdown of existing system. Perform work required at other than standard working hours where owner cannot approve outages during regular working hours. Provide temporary power and temporary wiring as required to maintain operation as directed by the owner or engineer to facilitate construction. Protect existing buildings and equipment during construction as required.

3.5 ELECTRICAL SERVICE.

- A. Description of System:
 1. The Electrical Utility Company will provide the electrical service of the characteristics as shown on the Drawings. This Contractor's work will begin where the Utility Company's work ends.
 2. The Contractor shall furnish all labor, materials, etc., necessary for a complete approved electrical service as required for this project, including inspection and approval by the Utility and local Inspection Departments (if any) and inform the Engineer prior to energizing power lines.
 3. This Contractor shall notify the Utility Company in writing, with two copies to the Engineer, no later than ten (10) days after signing contracts as to

when this Contractor anticipates the building power service will be required.

- B. Construction Facilities:
1. The facilities and equipment required providing all electrical power for construction, lighting and balancing and testing consumed prior to final acceptance of the project shall be provided under this section of the specifications. All wiring, outlets and other work required to provide this power at the site and within the building for all trades shall be arranged for, furnished and installed under this section of the specifications including any fee, charge or cost due the utility company for temporary power installation or hook-ups.
 2. Facilities shall be furnished in a neat and safe manner in compliance with governing codes, good working practices and OSHA regulations.
- C. Underground Electrical Service:
1. Furnish and install underground 277/480 volt 3ph, 4 wire service from power company pad-mount transformer to main service equipment. Seal conduit with duct-seal where entering building.
 2. The underground service shall comply with all the requirements of the NEC, local Utility Company and local enforcing authority.
 3. The concrete pad shall be furnished and installed by this Contractor and shall comply with the Utility Company's requirements.
 4. Furnish and install buried primary conduits from pad mount transformers to the FPL service riser or point of connection. The primary conduits shall be sized by FPL and installed per FPL requirements except be a minimum of 48" deep and be concrete encased within the property site boundaries. Coordinate with FPL and provide site routing layout drawing in submittals.
- D. Metering: The necessary C.T. cabinet(s), UTB and STB cabinets shall be furnished and installed by this Contractor. Approval of the CT, UTB and STB Cabinets by the Utility Company must be obtained by this Contractor prior to submitting the Shop Drawings of the cabinet(s). Meter bases shall be furnished and installed by this contractor. Provide aluminum meter bases. Metering bases and conduits must be installed in accordance with the Utility Company requirements.
- E. FP&L requirements. Work to be completed under this section shall be in accordance with FP&L documentation and standards.

End of Section

SECTION 26 05 11

SPECIAL ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install complete and make operational, electrical and process instrumentation systems for the Collier County Utilities Department as shown on the Drawings and as specified herein.
- B. The work shall include furnishing, installing and testing the equipment and materials specified in other Sections of the Specifications and shown on the Drawings. Provide all required coordination and supervision where work connects to or is affected by work of others, and comply with all requirements affecting this Division. Work required under other divisions, specifications or drawings, indicated to be performed by this Division shall be coordinated with the Contractor and such work performed at no additional cost to Owner including but not limited to electrical work required for roll-up doors, control panel installation, instrumentation and control installation, etc.
- C. It is the intent of these Specifications that the electrical system shall be suitable in every way for the service required. All material and all work which may be reasonably implied as being incidental to the work of this Section shall be furnished at no extra cost. The work shall include but not be limited to furnishing and installing the following:
 1. Conduit, wire and field connections for all motors, motor controllers, control devices, control panels and electrical equipment furnished under other Divisions of these specifications.
 2. Conduit, wiring and terminations for all field-mounted instruments furnished under other Divisions of these specifications, including process instrumentation primary elements, transmitters, local indicators and control panels. Lightning and surge protection equipment wiring at process instrumentation transmitters. Install vendor furnished cables specified under other Divisions of these specifications.
 3. Power wiring for all heating, ventilating, and air conditioning (HVAC) equipment furnished under other divisions of the specifications, including power wiring for 120 volt motors, thermostats, fan motors, dampers and other HVAC in line unit wiring.
 4. The drawings and specifications describe specific sizes of switches, breakers, fuses, conduits, conductors, motor starters and other items of wiring equipment. These sizes are based on specific items of power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). Wherever the contractor provides power consuming equipment which differs from, the basis of design, drawings and specifications, the wiring and associated circuit components for such equipment shall be changed to proper sizes to match at no additional expense to the Owner.
 5. A complete raceway system for the Data Network Cables and specialty cable systems. Install the Data Network Cables and other specialty cable systems furnished under other divisions in accordance with system integrator and the system manufacturers' installation instructions. Review the raceway layout, prior to installation, with the system integrator and the cable manufacturer to ensure raceway compatibility with the systems and materials being furnished.
 6. Furnish and install precast manholes and precast handholes. Furnish and install manhole and handhole frames and covers.
 7. Provide a complete grounding system and special grounds as required or noted.
 8. Provide Power and signal Surge Suppression systems.

9. Provide Concrete work for pad mounted equipment.
 10. Provide Instrumentation and control conduit and wiring systems and installation of field instrumentation.
 11. Provide Electrical testing of equipment
 12. Provide Lightning protection, bonding and grounding systems.
- D. Each bidder or their authorized representatives shall, before preparing their proposal, visit all areas of the existing site and structures in which work under this Division is to be performed and inspect carefully the present installation. The submission of the proposal by this bidder shall be considered evidence that their representative has visited the site and structures and noted the locations and conditions under which the work will be performed and that the bidder takes full responsibility for a complete knowledge of all factors governing the work.
 - E. Field verify all existing underground electrical and mechanical piping. Locate all openings required for work performed under this section.
 - F. Provide sleeves, guards or other approved methods to allow passage of items installed under this section.
 - G. The Contractor shall prepare and furnish electrical and instrumentation conduit layout shop drawings for yard electrical, within and under all roads, buildings and structures to the Engineer for approval prior to commencing work. Layouts shall include but not be limited to equipment, pull boxes, conduit routing, dimensioning, methods and locations of supports, reinforcing, encasement, materials, conduit sizing, equipment access, potential conflicts, building and yard lighting, and all other pertinent technical specifications for all electrical and instrumentation conduits and equipment to be furnished. All layouts shall be drawn to scale on 24 x 36 sheets.
 - H. The work shall include complete testing of all equipment and wiring at the completion of work and making any minor correction changes or adjustments necessary for the proper functioning of the system and equipment. All workmanship shall be of the highest quality; substandard work will be rejected.
 - I. A single manufacturer shall provide panelboards, main breakers, transformers, disconnect switches, etc.
 - J. Contractor shall provide their own temporary power for miscellaneous power (drills, pumps, etc.). No facility circuits shall be used unless approved by the engineer. Any temporary added shall be removed at job completion.
 - K. Complete coordination with other contractors. Contractor shall coordinate with all other contractors equipment submittals and obtain all relevant submittals.
 - L. Mount transmitters, process instruments, operator's stations, etc. furnished under other Divisions of these specifications.
 - M. Concrete electrical duct encasement, including but not limited to excavation, concrete, conduit, reinforcement, backfilling, grading and seeding is included. Excavation, bedding material, forms, concrete and backfill for underground raceways; forms and concrete for electrical equipment furnished herein is included in this Division.

1.02 QUALIFICATIONS

- A. The electrical contractor shall have regularly engaged in the installation of industrial electrical power systems for a minimum period of ten (10) years. When requested by the engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- B. Provide a field superintendent who has had a minimum of ten (10) years previous successful experience on projects of comparable size and complexity. Superintendent shall be present at all times that work under this Division is being installed or affected. A resume of the Superintendent's experience shall be submitted to Engineer before starting work.

1.03 RELATED WORK

- A. Submittals Section 01310
- B. Quality Control Section 01450
- C. Cast in place concrete work, including concrete encasements for electrical duct banks, equipment pads, and reinforcing steel, is specified in other Divisions.
- D. Excavation and backfilling, including gravel or sand bedding for underground electrical work is specified in other Divisions.

1.04 REFERENCE STANDARDS

- A. Electric equipment, materials and installation shall comply with the latest edition of National Electrical Code (NEC) and with the latest edition of the following codes and standards:
 - 1. National Electrical Safety Code (NESC)
 - 2. Occupational Safety and Health Administration (OSHA)
 - 3. National Fire Protection Association (NFPA)
 - 4. National Electrical Manufacturers Association (NEMA)
 - 5. American National Standards Institute (ANSI)
 - 6. Insulated Cable Engineers Association (ICEA)
 - 7. Instrument Society of America (ISA)
 - 8. Underwriters Laboratories (UL)
 - 9. Factory Mutual (FM)
 - 10. International Electrical Testing Association (NETA)
 - 11. Institute of Electrical and Electronic Engineers (IEEE)
 - 12. American Society for Testing and Materials (ASTM)
 - 13. Electrical Safety in the Workplace (NFPA70E-2012)
 - 14. Florida Building Code
 - 15. Local Codes and Ordinances
- B. All electrical equipment and materials shall be listed by Underwriter's Laboratories, Inc., or a nationally recognized Electrical Testing Agency and shall bear the appropriate UL listing mark or classification marking. Equipment, materials, etc. utilized not bearing a UL certification shall be field or factory UL certified prior to equipment acceptance and use. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.
- C. All materials shall be new and free of defects, and shall be U.L. listed, bear the U.L. label or be labeled or listed with an approved,. Where no labeling or listing service is available for certain types of equipment, test data shall be submitted to prove to the Engineer that equipment meets or exceeds available standards.

1.05 ENCLOSURE TYPES

- A. Unless otherwise specified herein or shown on the Drawings, electrical enclosures shall have the following ratings:
 - 1. NEMA 1 for dry, non-process indoor locations.
 - 2. NEMA 12 for "DUST" locations.
 - 3. NEMA 4X for all outdoor locations, rooms below grade (buried vaults), "DAMP" and "WET" locations.
 - 4. NEMA 4X for "CORROSIVE" locations.
 - 5. NEMA 7 (and listed for use in the area classifications shown) for "Class I Division 1 Group D", "Class I Division 2 Group D" and "Class II Division 1" hazardous locations shown on the Drawings.

1.06 CODES, INSPECTION AND FEES

- A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction. The installation shall comply with the governing state and local codes or ordinances. Completed electrical installation shall be inspected and certified by all applicable agencies that it is in compliance with all codes. Comply with latest utility company regulations.
- B. Obtain all necessary permits and pay all fees required for permits and inspections. It is the contractor's responsibility to contact the required Utility Company to determine if any fees, charges or costs will be due the Utility Company, as required by the Utility Company for temporary power, installations, hook-ups, etc. This fee, charge or cost shall be included in this contractor's bid price.

1.07 TESTS AND SETTINGS

- A. Test systems and equipment furnished under Division 16 and other divisions supplying electrical equipment. Repair or replace all defective work and equipment. Refer to Acceptance Testing section and the individual equipment sections for additional specific testing requirements.
- B. Make adjustments to the systems and instruct the Owner's personnel in the proper operation of the systems.
- C. In addition to the specific testing requirements listed and the individual Sections, the following minimum tests and settings shall be performed. Submit test reports upon completion of testing.
 - 1. Mechanical inspection, testing and settings of circuit breakers, disconnect switches, motor starters, overload relays, control circuits and equipment for proper operation.
 - 2. Check the full load current draw of each motor. Where power factor correction capacitors are provided the capacitor shall be in the circuit at the time of the measurement. Check ampere rating of thermal overloads for motors and submit a typed record to the Engineer of the same, including driven load designation, motor service factor, horsepower, and Code letter. If incorrect thermal overloads are installed replace same with the correct size overload.
 - 3. Check power and control power fuse ratings. Replace fuses if they are found to be of the incorrect size.
 - 4. Check settings of the motor circuit protectors. Adjust settings to lowest setting that will allow the motor to be started when under load conditions.
 - 5. Check motor nameplates for correct phase and voltage. Check bearings for proper lubrication.
 - 6. Check rotation of motors prior to testing the driven load. Disconnect the driven equipment if damage could occur due to wrong rotation. If the rotation is incorrect for the driven equipment correct motor connections at the motor terminal box.
 - 7. Check interlocking, control and instrument wiring for each system and/or part of a system to prove that the system will function properly as indicated by control schematic and wiring diagrams.
 - 8. Inspect each piece of equipment in areas designated as HAZARDOUS to ensure that equipment of proper rating is installed.
 - 9. Verify all terminations at transformers, equipment, panels and enclosures by producing a 1, 2, 3 rotation on a phase sequenced motor when connected to "A", "B" and "C" phases.
 - 10. Check all wire and cable terminations. Verify to the Engineer connections meet the equipments torque requirements.
 - 11. Field set all transformer taps as required to obtain the proper secondary voltage.
 - 12. Infra-red hot spot inspection shall be made of all electrical equipment including

but not limited to switchgear, motor control centers, transformers, switches, power and control panels, etc. This shall be done under representative load conditions before the equipment is used by the Owner.

1.08 PHASE BALANCING

- A. The Drawings do not attempt to balance the electrical loads across the phases. Circuits on panelboards shall be field connected to result in evenly balanced loads across all phases.
- B. Field balancing of circuits shall not alter the conductor color coding requirements as specified herein.

1.09 EQUIPMENT IDENTIFICATION

- A. Identify equipment (disconnect switches, control stations, etc) furnished under Division 26 with the name of the equipment it serves. Control panels, panelboards, main breakers, junction or terminal boxes, etc, shall have nameplate designations as shown on the Drawings. Nameplates shall adequately describe the function of the particular equipment involved. Where nameplates are detailed on the drawings, inscription and size of letters shall be as shown and shop drawing submitted for approval. Nameplates for panelboards and switchboards shall include the panel designation, voltage and phase of the supply. For example, "Panel A, 277/480V, 3-phase, 4-wire". The name of the machine on the nameplates for a particular machine shall be the same as the one used on all motor starters, disconnect and P.B. station nameplates for that machine.
- B. Nameplates shall be engraved, laminated plastic, not less than 1/16-in thick by 3/4-in by 2-1/2-in with 3/16-in high white letters on a black background. Attach with brass nuts and bolts.
- C. Electrical systems shall be identified at junction and pull boxes, terminal cabinets and equipment racks. Electrical contractor is responsible for nameplates on electrical equipment supplied by other divisions and installed and wired by electrical including all instrumentation and controls equipment. A portion of existing equipment affected by this contract shall also receive nameplates as determined by the Engineer.
- D. Nameplates shall be screw mounted to NEMA 1 enclosures. Nameplates shall be bonded to all other enclosure types using an epoxy or similar permanent waterproof adhesive. Two sided foam adhesive tape is not acceptable. Where the equipment size does not have space for mounting a nameplate, the nameplate shall be permanently fastened to the adjacent mounting surface. Cemented nameplates shall not be drilled.
- E. All voltages (e.g. 480 volts, 240 volts, etc.) within pull boxes, junction boxes etc. shall be identified on the front exterior cover. Signs shall be red background with white engraved lettering, lettering shall be a minimum of 1" high.
- F. All receptacles, wall switches, lighting fixtures, photo cells, emergency lights, exit lights, etc. shall be identified with the panel and circuit to which it is connected. Identification shall be with machine generated labels with 1/4" high letters.

1.10 Abbreviations or initials used.

A/C	Air Conditioning
A.C.	Alternating Current
AFF	Above Finished Floor
AFG	Above Finished grade
AHU	Air Handler Unit
AIC	Amps interrupting Capacity
AL	Aluminum
AMP	Ampere

ANSI	American National Standards Institute
ATS	Automatic Transfer Switch
AUX	Auxiliary
AWG	American Wire Gauge
BKR	Breaker
°C	Degrees Centigrade
CAB	Cabinet
C.	Conduit or Conductor
C.B.	Circuit Breaker
CFM	Cubic Feet per Minute
CKT.	Circuit
COND.	Conductor
Conn.	Connection
CP	Control Panel
CPT	Control Power Transformer
CT	Current Transformer
CU.	Copper
DC	Direct Current
Deg.	Degree
Disc.	Disconnect
DO	Draw Out
DPST	Double Pole Single Throw
EMT	Electric Metallic Tubing
E-Net	Ethernet Network
E.C.	Electrical Contractor
E.O.	Electrically Operated
°F	Degrees Fahrenheit
FLA	Full Load Amperes
FHP	Fractional Horsepower
FM	Factory Mutual
FPS	Feet per Second
FT.	Feet
FVNR	Full Voltage Non-Reversing
GFI (GFIC)	Ground Fault Interrupting
gnd.(GD.)	Ground
hp.	Horsepower
hr.	Hour
IEEE	Institute of Electrical and Electronic Engineers
in.	Inches
JB	Junction Box
KV	Kilovolt
KVA	Kilo-Volt-Amps
KW	Kilowatts
LCP	Local Control Panel
LED	Light Emitting Diode
max.	Maximum
MCB	Main Circuit Breaker
MCC	Motor Control Center
MCP	Motor Circuit Protector
min.	Minimum
MLO	Main Lugs Only
MTS	Manual Transfer Switch
N.	Neutral
NEC	National Electric Code
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
NETA	National Electrical Testing Association
NFPA	National Fire Protection Association

NIC.	Not in Contract
NF	Non Fused
No.	Number
ph	Phase
OCU	Odor Control Unit
OCP	Over Current Protection Device
OL	Overload
OSHA	Occupational Safety and Health Act
PB	Pullbox
Ph.	Phase
PNL	Panelboard
PR	Pair
PWR	Power
PF	Power Factor
Pri	Primary
psi	Pounds Per Square Inch
PT	Potential Transformer
PVC	Polyvinyl Chloride
RLA	Running Load Amps
RMS	Root-Means-Square
RPM	Revolutions Per Minute
Recpt.	Receptacle
RTD	Resistance Temperature Device
RVNR	Reduced Voltage Non-Reversing
SCA	Short Circuit Amps
SCC	Short Circuit Current
SCCR	Short Circuit Current Rating
Sec.	Secondary
S/N	Solid Neutral
SPST	Single Pole Single Throw
SSRV	Solid State Reduced Voltage
SW.	Switch
SWBD	Switchboard
SWGR	Switchgear
TEFC	Totally Enclosed Fan Cooled
TSP	Twisted Shielded Pair
TYP	Typical
Temp.	Temperature
UL	Underwriters Laboratories
UNO	Unless Noted Otherwise
V	Volt
VFD	Variable Frequency Drive
WP	Weatherproof
XFMR	Transformer

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SLEEVES AND FORMS FOR OPENINGS

- A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all necessary slots for electrical work and form before concrete is poured.
- B. Exact locations are required for stubbing-up and terminating concealed conduit. Obtain shop drawings and templates from equipment vendors or other subcontractors and locate the concealed conduit before the floor slab is poured.
- C. Where setting drawings are not available in time to avoid delay in scheduled floor slab pours, the Engineer may allow the installations of such conduit to be exposed. Requests for this deviation must be submitted in writing. No additional compensation for such change will be allowed.

- D. Seal all openings, sleeves, penetration and slots.

3.02 INSTALLATION

- A. Any work not installed according to the Drawings and this Division or without approval by the Engineer shall be subject to change as directed by the Engineer. No extra compensation will be allowed for making these changes.
- B. Electrical equipment shall at all times during construction be adequately protected against mechanical injury or damage by water. Electrical equipment shall not be stored out-of-doors. Electrical equipment shall be stored in dry permanent shelters. If an apparatus has been damaged, such damage shall be repaired at no additional cost. If any apparatus has been subject to possible injury by water, it shall be replaced at no additional cost to the Owner, the damaged unit(s) or systems shall remain on site and returned to the manufacturer after the replacement unit(s) or systems have been delivered to the site. Under no circumstances will electrical equipment damaged by water be rehabilitated or repaired, new equipment shall be supplied and all cost associated with replacement shall be borne by the Contractor.
- C. Equipment that has been damaged shall be replaced or repaired by the equipment manufacturer, at the Engineer's discretion.
- D. Repaint any damage to factory applied paint finish using touch-up paint furnished by the equipment manufacturer. The entire damaged panel or section shall be repainted at no additional cost to the Owner.

3.03 MANUFACTURERS SERVICE

- A. Provide manufacturer's services for testing and start-up of all major electrical equipment: VFDs, ATS, Gensets, MCCs, Switchboards, Switchgear, Etc.
- B. Testing and startup shall not be combined with training. Testing and start-up time shall not be used for manufacturers warranty repairs.
- C. The manufacturers of the above listed equipment shall provide experienced Field Service Engineer to accomplish the following tasks:
 - 1. The equipment shall be visually inspected upon completion of installation and prior to energization to assure that wiring is correct, interconnection complete and the installation is in compliance with the manufacturer's criteria. Documentation shall be reviewed to assure that all Drawings, operation and maintenance manuals, parts list and other data required to check out and sustain equipment operation is available on-site. Documentation shall be red-lined to reflect any changes or modifications made during the installation so that the "as-built" equipment configuration will be correctly defined. Spare parts shall be inventoried to assure correct type and quantity.
 - 2. The Field Service Engineers shall provide engineering support during the energization and check-out of each major equipment assembly. They shall perform any calibration or adjustment required for the equipment to meet the manufacturer's performance specifications.
 - 3. Upon satisfactory completion of equipment test, they shall provide engineering support of system tests to be performed in accordance with manufacturer's test specifications.
 - 4. A final report shall be written and submitted to the Contractor within fourteen days from completion of final system testing. The report shall document the inspection and test activity, define any open problems and recommend remedial action. The reports after review by the Contractor shall be submitted to the Engineer.

3.04 TRAINING

- A. The cost of training programs to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable,

- shall be directly related to the system being supplied.
- B. Provide detailed O&M manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.
 - C. The training program shall represent a comprehensive program covering all aspects of the operation and maintenance including trouble-shooting of each system.
 - D. All training schedules shall be coordinated with and at the convenience of the Owner. Shift training may be required to correspond to the Owner's working schedule. The training shall be conducted with record "as-built" drawings sufficient for each class member.
 - E. The Contractor shall submit an overview of the proposed training plan. This overview shall include, for each course proposed:
 - 1. An overview of the training plan.
 - 2. Course title and objectives.
 - 3. Recommended types of attendees.
 - 4. Course Content - A topical outline.
 - 5. Course Format - Lecture, laboratory demonstration, etc.
 - 6. Schedule of training courses including dates, duration and locations of each class.
- 3.05 The work under this Division shall include a two-year warranty. This warranty shall be by the Contractor to the Owner for any defective workmanship or material that has been furnished under this Contract at no cost to the Owner for a period of two years from the date of substantial completion of the System. This guarantee shall not include light bulbs or batteries in service after six months from date of Substantial Completion of the System.

END OF SECTION

SECTION 26 05 19

LOW VOLTAGE WIRES AND CABLES

1.01 GENERAL

A. Referenced Standards:

1. Institute of Electrical and Electronics Engineers, Inc./American National Standards Institute (IEEE/ANSI):
2. Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies.
3. National Electrical Manufacturers Association (NEMA): ICS 4, Industrial Control and Systems: Terminal Blocks.
4. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA): WC 57/S-73-532, Standard for Control Cables: WC 70/S-95-658, Non-Shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
5. National Fire Protection Association NFPA-70, National Electrical Code (NEC).
6. Underwriters Laboratories, Inc. (UL44): Standard for Safety Thermoset-Insulated Wires and Cables; (UL83): Standard for Safety Thermoplastic-Insulated Wires and Cables; UL467 Standard for Safety Grounding and Bonding Equipment. UL486A Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors; UL 486C, Standard for Safety Splicing Wire Connections. UL510, Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.

B. Definitions:

1. Building Wire: Copper single conductor, cross link polyethylene insulated; type XHHW-2;
2. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.
3. Instrumentation Cable (Analog signal cable): Multiple conductor, polyethylene insulated, twisted Pair/Triad, with individual Pair/Triad shield and outer overall shield and outer sheath. Used for the transmission of low current (e.g., 4-20mA DC) using No. 16 AWG conductors. Common Types, TSP: Twisted shielded pair, TST: Twisted shielded triad.
4. Control Cable: Multi-conductor, insulated, with outer sheath containing building wires, No. 14, AWG. With overall shield where specified. Type SIS and MTW approved for use in the wiring of control equipment within control panels and field wiring of control equipment within switchgear, switchboards, motor control centers; otherwise type XHHW-2.
5. Power Cable: Multi-conductor, insulated, with outer sheath containing building wire, No. 12 AWG and larger. Rated XHHW-2
6. Digital signal cable: Used for the transmission of digital signals between computers, PLC's, RTU's, etc. Common Types: Ethernet UTP-unshielded twisted pair.

1.02 Power Conductors:

- ##### A.
- Branch circuits and feeder conductors for electric power shall be stranded copper type XHHW-2 cross-link polyethylene (XLP) insulation and derated to 75 degrees Centigrade. No aluminum wiring shall be permitted. Wire shall be in accordance to NEC and minimum No. 12, except that branch "homeruns" over 50 ft. in length shall be minimum No. 10 for 120/208V circuits. All branch lighting circuits serving HID and Fluorescent fixtures shall be minimum #10 with each circuit provided with a

separate neutral. All wire shall be manufactured in the USA.

- B. Motor leads from variable frequency drives to driven motor shall be shielded VFD drive cable for all VFD motors. Provide flexible VFD shielded drive cables, 3 Class-I conductor cable plus 3 trisectional green insulated ground wires. Provide electrostatic shielding of tinned copper braided shield with aluminum-polyester laminated tape shielding system. Cross-linked polyolefin insulation system and neoprene outer jacket, type TC cable as manufactured by Rockbestos-Surprenant Cable Corp. or equal. Shielded VFD motor cables require increased conduit sizes over standard wire installations. Contractor to verify conduit sizes.
- C. Taps and Splices:
 - 1. All power wiring taps and splices in No. 8 or smaller wire shall be fastened together by means of terminal strips except within lighting fixtures and wiring devices where conformance to NEC practices will be acceptable (Twist/screw on type connectors). All taps and splices in wire larger than No. 8 shall be made with compression type connectors and taped to provide insulation equal to wire. Tape shall be heavy duty, flame retardant and weather resistant vinyl electrical tape, minimum 7 mil premium grade with an operating temperature of 0 degree F. to 220 degree F. Provide tape meeting UL 510 and CSA standard C22.2.
 - 2. All taps and splices in manholes or in ground pull boxes, etc. shall be approved by the engineer on a case by case basis; be made with high press long barrel double crimp compression type connectors and covered with Raychem heavy wall cable sleeves (type CTE or WCS) with type "S" sealant coating. Install sleeve kits as per manufacturer's installation instructions.
- E. Color Coding:
 - 1. All power feeders and branch circuits No. 6 and smaller shall be wired with color-coded wire with the same color used for a system throughout the building. Power feeders above No. 6 shall either be fully color-coded or shall have black insulation and be similarly color-coded with tape or paint in all junction boxes and panels. Tape or paint shall completely cover the full length of conductor insulation within the box or panel except for the wire markings.
 - 2. Unless otherwise approved, color-code shall be as follows: Neutrals to be white for 120/208V system, natural grey for 277/480V system; ground wire green, bare or green with yellow strips. Nominal Voltage: 120/208V, Phase A -black; Phase B - red; Phase C - blue. 480/277V, Phase A brown; Phase B - orange; Phase C - yellow. All switch legs, other voltage system wiring, control and interlock wiring shall be color-coded other than those above. In exiting or expansion projects, comply with existing color coding established within the facility.

1.03 Instrumentation and Control Cable:

- A. Multiconductor and Multi pair Process instrumentation cable shall be #16 AWG stranded, twisted pair, 600 V, (XLP) cross link polyethylene insulated, aluminum tape pair shielding, cross link polyethylene or chlorinated polyethylene (CPE) overall sheathed and shielded, type TC instrument cable as manufactured by the American Insulated Wire Co., Belden Wire Co. or equal.
- B. Multiconductor control cable shall be #14 AWG stranded, 600V, (XLP) cross link polyethylene insulated or polyolefin, with cross link polyethylene or chlorinated

polyethylene (CPE or Hypalon) overall sheathed type TC control cable except for control cable into and out of VFD cabinets. Multiconductor control cable into and out of VFD cabinets shall be as indicated above and in addition include an aluminum polyester tape overall shield and drain wire. As a contractor alternate to shielded control cable into and out of VFD cabinets, provide twisted shielded instrument cable as specified above. Contractor to provide increased conduit size as required if instrument cable alternate is used into and out of VFD cabinets.

1.04 Data Network Signal Cable:

- A. Ethernet Data Cable: Provide field cable that is Multi paired Data Signal cable, TIA 5638B Cat 5e, #22 AWG, twisted pair, 600V, PVC insulated, aluminum tape pair shielding, thermoplastic (PVC) overall sheathed and shielded, industrial ethernet cable as manufactured by the Allen Bradley 1585-C8HB or equal. Option to provide pre-molded M12 and RJ45 patch-cords Allen Bradley 1585D and 1585J is acceptable at contractor's option.
- B. Ethernet Cable Connections:
1. All conductor connections shall be to RJ45 and M12 compatible jacks.
 2. All conductors shall be marked with mylar wrap type "Brady" labels. Identification labels shall be permanent type and be machine printed. All terminal block terminations shall be labeled. The inside portion of the terminal cabinet doors shall display a protected terminal cabinet drawing with all connections shown and described as to color code, number assigned to connection function of conductor and destination.
 3. Wire shall be guided within terminal cabinets by cable supports. All conductors shall be neatly led to terminations.
 4. Instrumentation and control field cables on the unprotected side of SPD devices within the cabinet shall not run in parallel to the cables on the protected side of the SPD device. Separate cable supports (duct) will be provided.
 5. No splices shall be made within a conduit run or in manholes.
- C. Fiber Optic Cable: Fiber optic cable shall contain a minimum of six (6) optical tubing pairs or more as indicated on the drawings. Fiber optic tubing shall be multi fiber; 62.5/125 micron, tight-buffered, riser rated multi-fiber breakout type, with an Aramid strength member. Maximum attenuation through the fiber shall not exceed 3.0 dB/km at 850nm. Bandwidth shall be 200 Mhz-km at 850 nm. Cable shall be suitable for duct or aerial applications with a UV resistant black PVC sheath. Maximum tensile load shall be 3000 N short term and 1200 N long term. Minimum bend radius shall be 20X outside diameter under installation tensile load and 10X outside diameter long term tensile load. Operating temperature range shall be -40 to +85° c. Fiber optic cable shall be UL-listed OFNR rated as manufactured by Optical Cable Corporation, B-Series Ultra Fox. Fiber optic cable shall utilize mechanically spliced, field installable, LC compatible connectors. Connections shall have a typical loss of 0.2 dB or better. Heat or UV cured connections shall not be acceptable. Contractor shall terminate and test the fiber optic cable. Contractor shall measure the dB loss of each fiber over the cable length and provide a report of the test results to the Engineer for approval.

1.05 Cable Labeling and Separation:

- A. All plant control system field wiring shall be labeled per the instrumentation and control contractor loop drawings from the field device, through the intermediate cabinets, to the PLC cabinet. The labeling system shall be consistent throughout the loop and follow the standard tag designation: PLC#-Rack#-Slot#-Point# (example PLC1-R2-S3-P4).
- B. Provide for separation of Data, Instrumentation, Control Cables from power conductors. Provide a minimum of 24" inch separation for parallel run of power conduit and Data, Instrumentation or control conduit. This separation can be reduced to 8" if metallic grounded separation is provided.
- C. Connections:
 - 1. All conductor connections shall be on terminal strips including all spare conductors. Provide terminal strips in all cabinets; motor control centers; etc.
 - 2. All connections of stranded wire to screw terminals shall be by insulated spade lugs, crimp fastened to wire. Provide stranded wire crimp ferrules for all stranded wire connections not requiring spade lugs for screw type terminal blocks. The stranded wire ferrule is to be crimped to all stranded wire using a crimping tool specifically approved for crimping the size and type of ferrule.
 - 3. All conductors shall be marked with mylar wrap type "Brady" labels. Identification labels shall be permanent type and be machine printed. All terminal block terminations shall be labeled. The inside portion of the terminal cabinet doors shall display a protected terminal cabinet drawing with all connections shown and described as to color code, number assigned to connection function of conductor and destination.
 - 4. Wire shall be guided within terminal cabinets by cable supports. All conductors shall be neatly led to terminations.
 - 5. Instrumentation and control field cables on the unprotected side of SPD devices within the cabinet shall not run in parallel to the cables on the protected side of the SPD device. Separate cable supports (duct) will be provided.
 - 6. Cabinets: All cabinets shall be labeled with an engraved plastic laminate label riveted to the door.
 - 7. No splices shall be made within a conduit run or in manholes.
- D. All plant control system field wiring shall be labeled per the instrumentation and control contractor loop drawings from the field device, through the intermediate cabinets, to the PLC cabinet. The labeling system shall be consistent throughout the loop and follow the standard tag designation: PLC#-Rack#-Slot#-Point# (example PLC1-R2-S3-P4).
- E. Provide for separation of instrumentation, control and power conductors. Provide a minimum of 24" inch separation for parallel run of power conduit and instrumentation or control conduit. This separation can be reduced to 8" if metallic grounded separation is provided.

1.06 SUBMITTALS:

- A. Submit cut sheets on all major types of wires and cables including splicing tape, and terminating/splicing lugs, conductor identification systems and connectors and cable sleeves. Submit sample of all instrumentation and control cable. Sample shall be a

- B. minimum of 24" with exterior sheath clearly marked.
Submit sample of all cable identification systems products.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION; the terms “connect”, “ground” and “bond” are used interchangeably in this specification and have the same meaning

- A. This section specifies general grounding and bonding requirements of electrical equipment operations and to provide a low impedance path for possible ground fault currents.
- B. “Grounding electrode system” refers to all electrodes required by NEC, as well as including made, supplementary, perimeter counterpoise ground, lightning protection system grounding electrodes.

1.2 RELATED WORK

- A. Section 26 05 00, General electrical requirements.
- B. Section 26 05 19, Conductors & Cables

1.3 SUBMITTALS

- A. Submit in accordance with Division 26
- B. Shop Drawings:
 - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
 - 2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.
- C. Test Reports: Provide certified test reports of ground resistance.
- D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Project Engineer:
 - 1. Certification, by the Contractor, that the complete installation has been properly installed and tested.

1.4 APPLICABLE PUBLICATIONS

- A. American Society for Testing and Materials (ASTM):
- B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
- C. National Fire Protection Association (NFPA):
National Electrical Code (NEC) 2008
- D. Underwriters Laboratories, Inc. (UL):
Thermoset-Insulated Wires and Cables
Thermoplastic-Insulated Wires and Cables
Grounding and Bonding Equipment
Wire Connectors

PART 2 – PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

- A. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 2 AWG and smaller may be solid copper unless noted otherwise noted on the drawings. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 4 AWG and larger shall be permitted to be identified per NEC.

- B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 2 AWG and smaller may be ASTM B1 solid bare copper wire.
- C. Electrical System Grounding: Conductor sizes shall not be less than what is shown on the drawings and not less than required by the NEC, whichever is greater.

2.2 SPLICES AND TERMINATION COMPONENTS

- A. Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

2.3 GROUND CONNECTIONS

- A. Above Grade:
 - 1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lock washers.
 - 2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.

PART 3 – EXECUTION

3.1 GENERAL

- A. Ground in accordance with the NEC, as shown on drawings, and as hereinafter specified.
- B. System Grounding:
 - 1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
 - 2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
- C. Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.

3.2 GROUNDING CONNECTIONS

- A. Make grounding connections that are below grade by exothermic weld. Make grounding connections that are above grade but are otherwise normally inaccessible (poured columns, within walls) with exothermic weld.

3.4 SECONDARY EQUIPMENT AND CIRCUITS

- A. Transformers:
 - 1. Exterior: Exterior transformers supplying interior service equipment shall have the neutral grounded at the transformer secondary. Provide a grounding electrode at the transformer.
 - 2. Separately derived systems (transformers downstream from service equipment): Ground the secondary neutral at the transformer. Provide a grounding electrode conductor from the transformer to the ground bar at the service equipment.
- B. Conduit Systems:
 - 1. Ground all metallic conduit systems. All conduit systems shall contain an equipment grounding conductor (except service entrance with grounded neutral). Ground conductor shall be bonded to metallic conduit systems at the entrance and exit from the conduit.
- D. Boxes, Cabinets, Enclosures, and Panelboards:
 - 1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes.

2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
 3. Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.
- E. Motors and Starters: Provide lugs in motor terminal box and starter housing or motor control center compartment to terminate equipment grounding conductors.
- F. Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.

3.5 CORROSION INHIBITORS

- A. When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.6 CONDUCTIVE PIPING

- A. Bond all conductive piping systems, interior and exterior, to the building to the grounding electrode system.

3.7 GROUND RESISTANCE

- A. Grounding system resistance to ground shall not exceed 2 ohms. Make necessary modifications or additions to the grounding electrode system for compliance without additional cost to the owner. Final tests shall assure that this requirement is met.
- B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.
- D. Below-grade connections shall be visually inspected by the Project Engineer prior to backfilling. Provide ground inspection wells at all ground rod locations.

3.8 GROUND ROD INSTALLATION

- A. Drive each rod vertically in the earth, not less than 20 feet in depth.
- B. Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints. Make above grade accessible ground connections with mechanical pressure type ground connectors.
- C. Where rock prevents the driving of vertical ground rods, drill rock then install rod. Backfill with flowable fill or concrete mix. Obtain the necessary permits if required for drilling.

END OF SECTION

SECTION 26 05 29
SUPPORTING DEVICES

PART 1 - GENERAL

1.01 SCOPE;

- A. The work under this sections includes conduit and equipment supports, straps, clamps, steel channel, etc, and fastening hardware for supporting electrical work. Furnish and install all supports, hangers and inserts required to mount fixtures, conduit, cables, pull boxes and other equipment furnished under this Division. All supporting devices and hardware exterior of buildings or interior of structures except in air conditioned spaces shall be stainless steel. Aluminum and non metallic supports (fiberglass) and hardware will be reviewed by the Engineer on a case-by-case basis.
- B. All items shall be supported from the structural portion of the building. Supports and hangers shall be of a type approved by Underwriters' Laboratories. Wire or plastic tie straps shall not be used as a support. Boxes and conduit shall not be supported or fastened to ceiling suspension wires or to ceiling channels.
- C. The Contractor shall furnish and install all sleeves that may be required for openings through floors, wall etc. Where plans call for conduit to be run exposed, the Contractor shall furnish and install all inserts and clamps for the supporting of conduit. If the Contractor does not properly install all sleeves and inserts required, contractor to provide cutting and patching to the satisfaction of the Engineer.

1.02 SUBMITTALS: Product Data: Provide data for support channel.

1.03 QUALITY ASSURANCE: Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

PART 2 - PRODUCTS

2.01 MATERIAL

- A. Support Channel: Stainless steel throughout except galvanized steel in conditioned interior areas.
- B. Hardware: Stainless steel throughout
- C. Minimum sized threaded rod for supports shall be 3/8".
- D. Conduit clamps, straps, supports, etc., shall be stainless steel or malleable iron. One-hole straps shall be heavy duty type.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All steel conduits shall be securely fastened in place on maximum of 6 foot intervals; all PVC conduits shall be securely fastened in place on maximum of 3 foot intervals vertically and 2 foot intervals horizontally. Hangers, supports or

fastenings shall be provided at each elbow and at the end of each straight run terminating at a box or cabinet. The required strength of the supporting equipment and size and type of anchors shall be based on the combined weight of conduit, hanger and cables. Horizontal and vertical conduit runs may be supported by two-hole malleable straps, clamp-backs, or other approved devices with suitable bolts, expansion shields (where needed) or beam-clamps for mounting to building structure or special brackets.

- B. On concrete or masonry construction, use "Tapcon" type fasteners. For brick construction, insert anchors shall be installed with round head machine screws. In wood construction, round head screws shall be used. An electric or hand drill shall be used for drilling holes for all inserts in brick, concrete or similar construction. Steel members shall be drilled and tapped, and round head machine screws shall be used. All screws, bolts, washers, etc., used for supporting conduit or outlets shall be fabricated from stainless steel, or approved substitution.
- C. Fasten hanger rods, conduit clamps, outlet, junction and pull boxes to building structure using preset inserts, beam clamps, expansion anchors, or spring steel clips (interior metal stud walls only). Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchors on concrete surfaces; sheet metal screws in sheet metal studs and wood screws in wood construction.
- D. File and de-bur cut ends of support channel and spray paint with cold galvanized paint to prevent rusting. Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit. Do not drill structural steel members unless approved by the engineer.
- E. Fabricate supports from stainless steel or galvanized steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts. Install surface-mounted cabinets and panelboards with minimum of four anchors. Provide steel channel supports to stand cabinet one inch (25 mm) off wall.
- F. Furnish and install all supports as required to fasten all electrical components required for the project, including free standing supports required for those items remotely mounted from the building structure, catwalks, walkways etc.

END OF SECTION

SECTION 26 05 51 CONDUIT SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Description of System: This Section includes requirements for raceways, fittings, boxes, enclosures, and cabinets for electrical, instrumentation and control system wiring.
- B. Only heavy wall PVC (Schedule 80) shall be used for all raceways trapped underground without concrete encasement protection. Conduits in concrete encasement use Schedule 40-PVC. Above ground in areas subject to chemical degradation (chemical storage, chlorine rooms, odor control and scrubber area, etc) use Schedule 80-PVC. Use rigid galvanized conduit or aluminum conduit for exposed above grade interior area. Electrical Metallic Tubing shall be used within air conditioned electrical rooms for power and for instrumentation and control conduits. Use rigid aluminum conduit above grade on exterior of buildings and in above grade interior wet locations. Where PVC conduit penetrates a floor from underground or in a slab; a black mastic coated rigid steel conduit elbow shall be used for all conduits.
- C. Minimum conduit size for all systems shall be 3/4". All conduits shall be U.L. listed and labeled. Conduit sizes shown on the drawings are to aid the contractor in bidding only; the contractor is responsible for conduit sizes as required by NEC fill tables but do not provide smaller conduits than indicated. The contractor is responsible to coordinate the required conduit sizes and conductor quantities for all control and instrumentation system conduit and wiring with the controls subcontractor prior to installation.
- D. Provide stainless steel or non-metallic conduit supports and 316 stainless steel hardware in all areas except air conditioned spaces which may be painted steel.

1.02 SUBMITTALS

- A. Product Data:
 - 1. Product data shall be submitted on:
 - a. Conduit, raceways, wireways.
 - b. Conduit fittings, boxes, enclosures and cabinets.
 - c. Surface metal raceway

PART 2 - PRODUCTS

2.01 ELECTRIC METALLIC TUBING

- A. Electric metallic tubing (thin wall) shall meet Federal EMT Specifications WW-C-563 ANSI C80.3.

2.02 RIGID METALLIC CONDUIT

- A. Hot dipped galvanized rigid steel. Federal Specification WW-C-581, ANSI C80.1.

2.03 FLEXIBLE CONDUIT

- A. Flexible, Nonmetallic, Liquid-Tight Conduit:
 - 1. Material: PVC core with fused flexible PVC jacket. UL 1660 listed for:
 - a. Dry Conditions: 80 degrees C insulated conductors.

- b. Wet Conditions: 60 degrees C insulated conductors.
 - 2. Manufacturers and Products:
 - a. Carlon; Carflex or X Flex.;
 - b. T & B; Xtraflex LTC or EFC.
- B. Flexible Steel Conduit: Continuous length, spirally wound steel strip, zinc-coated, each convolution interlocked with following convolution. Federal Specification WW-C-566. Liquid-tight Flexible Steel Conduit: Plastic (PVC) jacketed flexible steel conduit with copper bonding conductor (UL 1660). Flexible conduit fittings: UL 514B.

2.04 PVC CONDUIT

- A. PVC conduit shall be composed of High Impact Virgin homopolymer, PVC (polyvinyl chloride C-200 Compound), and shall conform to industry standards, and be UL 651 listed in accordance with Article 347 of National Electrical Code for underground and exposed use and NEMA standard TC-2. Materials must have tensile strength of 55 PSI, at 70oF, flexural strength of 11,000 PSI, compression strength of 8600 PSI. Manufacturer shall have five years' extruding PVC experience. Consistent with requirements provide PVC conduit products by one of the following manufacturers:
 - 1. Carlon
 - 2. Cantex
 - 3. J.M. Plastics
 - 4. Queen City Plastics

2.05 Rigid Aluminum Conduit

- A. Provide Rigid Aluminum Conduit of 6063 alloy in temper designation T-1. The fittings are of the same alloy. Provide threaded Rigid Aluminum Conduit to Underwriters Laboratories U.L. 6A, "Standard for Electrical Rigid Metal Conduit and manufactured to ANSI C80.5.
- B. Provide threaded aluminum conduit fittings, of 6063 alloy, cast aluminum with integral insulated throat as manufactured by Allied, OZ Gedney, T&B, Crouse-Hinds, Killark or Appleton.
- C. Provide supplementary corrosion protection for aluminum conduit imbedded in concrete or in contact with soil. Where aluminum conduits are in contact with or penetrate concrete, coat conduit with asphaltic or bitumastic type coating.

2.06 CONDUIT FITTINGS

- A. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
- B. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
- C. Fittings for EMT: Steel compression type.
- D. Fittings, surface boxes and conduit bodies for RGC shall be heavy cast ferralloy malleable iron with external raised hubs and mounting lugs; cadmium plated and enamel finish - Appleton, Crouse Hinds or approved substitution. Cover plates cast iron ferralloy.
- E. Fittings, surface boxes and conduit bodies for Rigid Aluminum Conduit shall be heavy cast aluminum with external raised hubs and mounting lugs;- Appleton, Crouse Hinds or approved substitution. Cover plates cast aluminum. Zinc die cast

- not acceptable.
- F. Conduit locknuts shall be aluminum throughout except steel is acceptable within air conditioned spaces.
 - G. Conduit expansion fittings shall be malleable iron, and shall be hot dipped galvanized inside and outside. These fittings shall have a four-inch expansion chamber to allow approximately two-inch movement parallel to conduit run in either direction from normal. They shall have factory-installed packing and internal tinned copper braid packing to serve as an emergency bonding jumper. Unless the fitting used is listed by Underwriters' Laboratories for use "without external bonding jumpers", an external copper bonding jumper shall be installed with each expansion fitting with one end clamped on each conduit entering fitting.
 - H. Flexible, Nonmetallic, Liquid-Tight Conduit shall meet requirements of UL 514B with High strength plastic body, complete with lock nut, O-ring seal, threaded ferrule, sealing ring. Threaded ferrule designed to ensure high mechanical pullout strength and watertight seal. Manufacturer, Carlon; Type LN or approved equal.
 - I. Ceiling outlet boxes shall be 4" octagonal or 4" square X 1-1/2" deep or larger as required for number and size of conductors and arrangement, size and number of conduits terminating at them. Switch, wall receptacle, telephone and other wall outlet boxes in drywall shall be 4" square X 1-1/2" deep. For furred-out block walls, provide 4" square box with required extension for block depth and required extension for drywall depth.
 - J. Covers for cast boxes (flush and surface) installed in damp or wet locations shall be UL approved for weatherproof locations (UL standard 498 and 514; OSHA standard Subpart "S"; NEMA Standard WD-1) with plug inserted and shall comply with NEC-410-57b; shall be heavy cast copper free aluminum with 2 coat baked epoxy finish; self closing door with stainless steel hinge and springs; EPDM gaskets. Provide Crouse Hinds, Appleton or equal. This requirement includes outlets mounted flush in exterior lighting poles.

PART 3 - EXECUTION

3.01 MOUNTING HEIGHT

- A. Height of wall outlets to bottom above finished floors shall be as follows, unless specifically noted otherwise. Verify with the Architectural plans and shop drawings for installing.

Switches	4'-0" Maximum to centerline
Receptacles	1'-4"
Lighting Panels (top of Panel Trim)	6'-6"
- B. Bottoms of outlets above counter tops or base cabinets shall be minimum 2" above counter top or backsplash, whichever is highest. Outlets may be raised so that bottom rests on top of concrete block course, but all outlets above counters in same area shall be at same height. It is the responsibility of this Division to secure cabinet drawings and coordinate outlet locations in relation to all cabinets as shown on plans, prior to rough-in, regardless of height shown on Division 16 drawings.
- C. Height of wall-mounted fixtures shall be as shown on the drawings or as required by Architectural plans and conditions. Fixture outlet boxes shall be equipped with fixture studs when supporting fixtures.

- D. Locate special purpose outlets as indicated on the drawings for the equipment served. Location and type of outlets shall be coordinated with appropriate trades involved. The securing of complete information for proper electrical roughing-in shall be included as work required under this section of specifications.

3.02 INSTALLATION

- A. All raceways shall be run in neat and workmanlike manner and shall be properly supported in accordance with latest edition of NEC with approved conduit clamps, hanger rods and structural fasteners except for PVC conduit installed in exterior locations. PVC conduit installed in exterior locations shall be supported at two foot intervals. Supporting conduit and boxes with wire is not approved. All raceways except those from surface-mounted switches, outlet boxes or panels shall be run concealed from view. Exposed raceways shall be supported with clamp fasteners with toggle bolt on hollow walls, and with lead expansion shields on masonry. Rigid steel box connections shall be made with double locknuts and bushings. Where PVC penetrates a floor from underground or in slab, a black mastic coated steel conduit elbow shall be used on all conduits. All individual bare copper ground conductors (i.e. service, transformer, or lightning protection grounds) shall be installed in PVC conduit, not metal conduit. This does not apply to bare copper ground conductors run with feeders (as specified in this section). Conduits shall be run parallel to building walls wherever possible, exposed or concealed, and shall be grouped in workmanlike fashion. Crisscrossing of conduits shall be minimized.
- B. All raceways runs, whether terminated in boxes or not, shall be capped during the course of construction and until wires are pulled in, and covers are in place. No conductors shall be pulled into raceways until construction work which might damage the raceways has been completed.
- C. All raceways shall be kept clear of plumbing fixtures to facilitate future repair or replacement of said fixtures without disturbing wiring. Except where it is necessary for control purposes, all raceways shall be kept away from items producing heat.
- D. All raceway runs in masonry shall be installed at the same time as the masonry so that no face cutting is required, except to accommodate boxes.
- E. All raceways shall be run from outlet to outlet exactly as shown on the drawings, unless permission is granted to alter arrangement shown. If permission is granted arrangement shall be marked on field set of drawings as previously specified.
- F. All underground raceways (with exception of raceways installed under floor slab) shall be installed in accordance with Section 300-5 of the NEC except that the minimum cover for any conduit shall be two feet. Included under this Section shall be the responsibility for verifying finished lines in areas where raceways will be installed underground before the grading is complete.
- G. All raceways shall have an insulated copper system ground conductor throughout the entire length of circuit installed within conduit in strict accordance with NEC. Grounding conductor shall be included in total conduit fill determining conduit sizes, even though not included or shown on drawings. Grounding conductors run with feeders shall be bonded to portions of conduit that are metal by approved ground

bushings.

- H. Insulated bushings shall be used on all rigid steel conduits terminating in panels, wire gutters, or cabinets, and shall be impact resistant plastic molded in an irregular shape at the top to provide smooth insulating surface at top and inner edge. Material in these bushings must not melt or support flame.
- I. Spare conduit stubs shall be capped and location and use marked with concrete marker set flush with finish grade or terminated in a manhole. Marker shall be 6" round X 6" deep with appropriate symbol embedded into top to indicate use. Also, tag conduits in panels where originating.
- J. All conduit stubbed above floor shall be separated with plastic interlocking spacers manufactured specifically for this purpose, or shall be strapped to Kindorf channel supported by conduit driven into ground or tied to steel.
- K. Raceways which do not have conductors furnished under this Division of the specifications shall be left with an approved nylon pullcord in raceway.
- L. Rigid Metallic Conduit electrical metallic tubing, flexible steel conduit and PVC conduit shall be manufactured within the United States.
- M. All connections to motors or other vibrating equipment (except dry type transformers) or at other locations where required shall be made with not less than 12" nor more than 20" of flexible liquid-tight steel conduit, using special type of connectors with strain relief fittings at both terminations of conduit. Flex connectors shall have insulated throat and shall be T & B 3100 Series or approved substitution. Use angle connectors wherever necessary to relieve angle strain on flex conduit. Connections to dry type transformers shall be made with flexible conduit. Typical length of flex conduit shall be limited to 20" unless specifically approved by the engineer.
- N. PVC joints shall be solvent welded. Threads will not be permitted on PVC conduit and fittings, except for rigid steel to PVC couplings. Installation of PVC conduit shall be in accordance with manufacturer's recommendations. PVC conduit shall not be used to support fixture or equipment. Field bends shall be made with approved hotbox. Heating with flame and hand held heat guns are prohibited.
- O. Expansion fittings shall be installed in the following cases: In each conduit run wherever it crosses an expansion joint in the concrete structure; on one side of joint with its sliding sleeve end flush with joint, and with a length of bonding jumper in expansion equal to at least three times the normal width of joints; in each conduit run which mechanically attached to separate structures to relieve strain caused by shift on one structure in relation to the other; in straight conduit run above ground which is more than fifty feet long and interval between expansion fittings in such a runs shall not be greater than 100 feet for steel conduit and 50 feet for PVC conduit.
- P. Electric metallic tubing (thin wall) shall be installed inside buildings above ground floor slab where not subject to mechanical injury or wet areas. Tubing shall be joined with steel fittings and steel compression connectors.
- Q. Rigid metallic conduit installed underground shall be coated with waterproofing black

mastic before installation, and all joints shall be recoated after installation.

- R. Conduit installations on roofs shall be kept to a bare minimum. Where required, conduit shall be rigid aluminum conduit, including couplings. Conduit shall be supported above roof at least 6 inches using approved conduit supporting devices. Supports to be fastened to roof using roofing adhesive as approved by roofing contractor.
- S. Underground cable identification: bury a continuous, pre-printed, bright colored metalized plastic (electronically traceable) ribbon cable marker with each underground conduit (or group of conduits), regardless of whether conduits are in ductbanks. Locate directly over conduits, 6" to 8" below finished grade. Delete this requirement under building slabs.
- T. Provide for separation of instrumentation, control and power conductors. Provide a minimum of 24" inch separation for parallel runs of power conduit to instrumentation or control conduit with either conduit being PVC or Aluminum. This separation can be reduced to 6" if metallic grounded separation is provided (steel conduit).
- U. All flush outlet boxes shall be mounted so that covers and plates will finish flush with finished surfaces without the use of shims, mats or other devices not submitted or approved for the purpose. Add-a-Depth rings or switch box extension rings are not acceptable. Plates shall not support wiring devices. Provide gang switches with common plate where two or more are indicated in the same location. Wall-mounted devices of different systems (switches, thermostats, etc.) shall be coordinated for symmetry when located near each other on the same wall. Outlets on each side of walls shall have separate boxes. Through-wall type boxes shall not be permitted. Back-to-back mounting shall not be permitted. Trim rings shall be extended to within 1/8" of finish wall surface. Outlet boxes mounted in metal stud walls, are to be supported to studs with two (2) screws inside of outlet box to a horizontal stud brace between vertical studs.

END OF SECTION

**SECTION 26 32 13
DIESEL ENGINE DRIVEN GENERATOR SETS
EMERGENCY RATED**

PART I - GENERAL

1.0 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install, put into operation, and field test the diesel engine driven generator unit, and controls as shown on the Drawings and specified herein. The equipment installation shall be coordinated in detail by the Genset distributor. The distributor shall supervise the installation of the equipment from off loading to startup.
- B. The installation, supervision, and the coordination of testing and startup of the system shall be provided by the installing contractor. The installing contractor shall be responsible for the complete coordination of the installation. The installing contractor shall be responsible to include all necessary equipment and services into the base bid for installation. Where shown on the drawings, accessory materials include but are not limited to sub-base tank, exhaust muffler system, cooling air ductwork, battery charger, ETC.
- C. These Specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the equipment as offered. It is, however, intended to cover the furnishing, the shop testing, and delivery and complete installation and field testing, of all materials, equipment and appurtenances for the complete units as herein specified, whether specifically mentioned in these Specifications or not.
- D. For all units there shall be furnished and installed all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not. The genset supplier is responsible for field testing of the entire installation and instruction of the regular operating personnel in the care, operation and maintenance of all equipment.
- E. Provide per the project scope all equipment as shown on the drawings but is not limited to supplying engine generator set complete, muffler, line circuit breaker, radiator cooling ductwork, vibration dampeners, etc.
- F. The generator Unit(s) shall be as manufactured by Cummins-Onan or Caterpillar with a standby rating as shown on the drawings. 1800RPM, 0.8 power factor, 277/480Volt, 3 phase.

1.1 DESCRIPTION OF SYSTEMS

- A. A complete package shall be provided by the generator set distributor, maintaining single source responsibility. The Contractor shall utilize the authorized distributor, who shall be responsible to furnish, document, instruct and supervise installation, adjust, and test the complete system as shown on the plans and specified herein.
- B. The Contractor shall furnish and install all interconnecting wiring as show on the authorized distributor's shop drawings, accessories, and the like whether or not specifically detailed on the plans or in the specifications. It shall be the responsibility of the contractor to ascertain such items from the authorized distributor and include

these costs in his bid. No additional payment will be made for items not specifically shown or detailed in the contract documents but needed for a complete installation.

- C. The unit shall be shipped to the jobsite by an authorized engine distributor having a parts and service facility within a 150 mile radius of the jobsite. In addition, and in order not to penalize the Owner for unnecessary or prolonged periods of time for service or repairs to the emergency system, the bidding generator set supplier must have no less than eighty percent (80%) of all engine replacement parts locally available at all times. Certified proof of this requirement shall be furnished to the Engineer upon request.
- D. Emergency warranty service response shall be guaranteed to be a maximum of four-hours between the time of emergency notification and arrival of service personnel on site. An emergency service condition shall be considered to exist when any failed standby power system hardware or software prevents or threatens to prevent the facility from fulfilling its intended purpose as determined by the owner or engineer. Non-emergency service requests shall be responded to within 2 business days. Telephone support for operating procedures and non-hardware problems shall be provided on an unlimited basis during the warranty period.
- E. All materials and parts comprising the units shall be new and unused, of current manufacture, and of the highest grade, free from all defects or imperfections. Workmanship shall conform to the best modern practices. Only new and current models will be considered. The units offered under these Specifications shall be the product of a firm regularly engaged in the production of engine-generator equipment and shall meet the requirements of the Specifications set forth herein.

1.2 SUBMITTALS

- A. Submit to the Engineer for review in accordance with division 1 Sections of the specifications, complete sets of installation drawings, schematics, and wiring diagrams which shall show details of installation and connections to the work of other Sections, including mounting drawing showing location and size of mounting bolts for the vibration isolators and brochures covering each item of equipment.
- B. Provide structural certification for the existing (or modified) mounting beams/structure on top of the existing fuel tank. Note the existing genset unit is lighter in weight since it is a two cycle machine. The new unit will be a 4-cycle machine in the range of 5000lb. Vendor shall analyze existing structure and propose changes and/or enhancements. Contractor provide structural certification for changes made from a professional structural engineer.
- C. In the event that it is impossible to conform with certain details of the Specifications due to different manufacturing techniques, describe completely all nonconforming aspects.
- D. The submittal data for each unit shall include, but not necessarily be limited to, the following:
 - 1. Installation drawings showing plan and elevations of the complete generator unit; foundation plan; exhaust silencer; starting battery; battery charger; fuel tank; and all other items requiring space for installation. Layout and stub-up locations of electrical and fuel systems.

2. Interconnect wiring diagram of complete emergency system, including generator, switchgear, fuel tank level monitor/transmitter, battery charger, remote alarm indications.
3. Engine mechanical data at varying loads up to full load, including heat rejection, exhaust gas flows, combustion air and ventilation air flows, noise data, fuel consumption, etc.
4. Generator electrical data including temperature and insulation data, cooling requirements, excitation ratings, voltage regulation, voltage regulator, efficiencies, waveform distortion and telephone influence factor.
5. Engine Data:
 - a. Manufacturer
 - b. Model
 - c. Number of cylinders
 - d. RPM
 - e. Bore x stroke
 - f. Piston speed, RPM
 - g. Make and model and descriptive literature of electric governor
 - h. Fuel consumption rate curves at 25,50,75,100% loads
 - i. Engine continuous pump drive duty rating
 - j. Gross engine horsepower to produce generator standby rating (including fan and all parasitic loads).
 - k. Manufacturer's and dealer's written warranty.
 - l. Emissions data
6. Generator Data:
 - a. Manufacturer
 - b. Model
 - c. Rated KVA
 - d. Rated kw
 - e. Voltage
 - f. Temperature rise above 40 degree C ambient
 - g. Generator efficiency including excitation losses and at 80 percent power factor
 - h. Generator resistances, reactances and time constants.
 - i. Generator current decrement curve.
 - j. Generator motor starting capability.
 - k. Generator thermal damage curve.
 - l. Line circuit breaker.
7. Generator Unit Control Data:
 - a. Actual electrical diagrams including schematic diagrams, and interconnection wiring diagrams for all equipment to be provided. Control panel schematics
 - b. Legends for all devices on all diagrams
 - c. Sequence of operation explanations for all portions of all schematic wiring diagrams
8. Generator Unit and Accessories:
 - a. Weight of skid mounted unit
 - b. Overall length
 - c. Overall width
 - d. Overall height
 - e. Exhaust pipe size
 - f. CFM of air required for combustion and ventilation
 - g. Heat rejected to jacket water and lubricating oil...BTU/hr
 - h. Heat rejected to room by engine and generator...BTU/hr
 - i. Jacket water heater connection diagram.

- j. Automatic load transfer switch(es).
- E. Submit to the Engineer operating and maintenance data as specified in 26 05 00 Basic Materials and Methods of this specification. Submit to the Engineer the equipment Manufacturer's Certificate of Installation, Testing and Startup Report.

1.3 SPARE PARTS

- A. The Manufacturer shall furnish one (1) complete spare replacement sets of all filter elements required for the generator unit.

PART 2 - PRODUCTS

2.1 RATINGS

- A. The rating of the generator set shall not exceed the Manufacturer's published standby rating. The gross engine horsepower required to produce the standby rating shall not exceed the Manufacturer's published continuous duty rating by more than 150 percent. Continuous duty rating shall be as defined in BS5514 or DIN6271 but in no case shall it exceed the Manufacturer's published continuous duty rating for the engine as used in continuous rated pump drive applications. The gross engine horsepower required for the generator set standby rating described above shall include all parasitic demands such as generator inefficiencies, fuel pumps, water pumps, radiator fan (for fan cooled models) and all accessories necessary to the unit's proper operation while operating at rated load and at a rotative speed not to exceed 1800 rpm.
- B. The diesel engine driven generator set shall be capable of producing the specified standby kw rating for continuous electrical service during interruption of the normal utility source and shall be certified to this effect by the Manufacturer for the actual unit supplied.

2.2 ENGINES

- A. The engine shall be full compression ignition, four cycle, single acting, solid injection engines, either vertical or "V" type. Speed shall not exceed 1800 revolutions per minute at normal full load operation. The engine governor shall be +/- 0.25 percent accuracy electronic type governor.
- B. The engine shall be capable of satisfactory performance on No. 2 fuel oil (ASTM Designation D396). Diesel engines requiring a premium fuel will not be considered.
- C. The engine shall be capable of operating at light loads for extended periods of time and shall provide a means to reduce carbonization. Periodic cleaning of exhaust ports shall not be required.
- D. The engine shall be equipped with fuel filters, lube oil filters, intake air filters, lube oil cooler, fuel transfer pump, engine driven water pump, and unit mounted instruments. The engine shall be provided with low oil pressure, high water temperature and overspeed safety shutdowns.
- E. Injection pumps shall be pressure time common rail type. The system shall be self bleeding and self priming in design. The fuel system shall provide redundant overspeed protection with one governor having a dual flywheel fuel limiting mechanical control and the other fail safe electric control. The governors shall be located within the fuel pump body without external linkages or adjustments. Fuel

injection pumps shall be positive action, constant-stroke pumps, activated by a cam driven by gears from the engine crankshaft. Fuel lines between injection pumps and valves shall be of heavy seamless tubing. Digital Electronic fuel injection systems shall be considered equal to common rail type pressure injection systems.

- F. The fuel system shall be equipped with fuel filters having replaceable elements. Filter elements shall be easily removable from their housing for replacing without breaking any fuel line connections, or disturbing the fuel pump, or any other part of the engine. All fuel filters shall be conveniently located in one accessible housing, ahead of the injection pumps so that the fuel will have been thoroughly filtered before it reaches the pump. No screens or filters requiring cleaning or replacement shall be used in the injection pump or injection valve assemblies. The engines shall be equipped with a built-in gear-type, engine-driven fuel transfer pump, capable of supplying fuel through the filters to the injection pump at constant pressure.
- G. The engine shall be provided with removable wet-type cylinder liners of close grained alloy iron, heat treated for proper hardness as required for maximum liner life. The cylinder block shall be a one piece stress relieved grey iron casting.
- H. The engine shall have a gear-type lubricating oil pump for supplying oil under pressure to main bearings, crank pin bearings, pistons, piston pins, timing gears, camshaft bearings, valve rocker mechanism and governor. Effective lubricating oil filters shall be provided and so located and connected that all oil being circulated is continuously filtered and cleaned. Filters shall be accessible, easily removed and cleaned and shall be equipped with a spring-loaded by-pass valve as an insurance against stopping of lubricating oil circulation in the event the filters become clogged. The engine shall have a suitable water cooled lubricating oil cooler.
- I. The engine shall be provided with one or more engine mounted dry type air cleaners of sufficient capacity to protect effectively the working parts of the engine from dust and grit.
- J. Provide fuel ramping control to limit black smoke and frequency overshoot.

2.3 COOLING SYSTEMS

- A. The engine shall be furnished with a unit mounted radiator type cooling system having sufficient capacity for cooling the engine when the diesel generator set is delivering full rated load in an ambient temperature of 122 degrees F. The engine shall be provided with a thermostatic valve placed in the jacket water outlet between the engine and the cooling source. This valve shall maintain the proper jacket water temperature under all load conditions.
- B. Closed circuit jacket water systems shall be treated with a rust inhibitor as recommended by the engine Manufacturer.
- C. A unit mounted thermal circulation type water heater incorporating a thermostatic switch shall be furnished to maintain engine jacket water to 70 degrees F. The heater shall be rated as shown on the drawings.

2.4 EXHAUST SYSTEMS

- A. The engine exhaust silencer shall be a critical grade and provided by the genset manufacturer. Silencer shall be sized and approved by the engine manufacture and

supported by acoustical and pressure loss calculation not to exceed 55db max at the property line.

- B. All exhaust equipment must be rated to withstand temperatures of approximately 1,000 degrees F. A flexible stainless steel pipe connection shall be provided between the engine exhaust stack and exhaust piping. One silencer raincap with counter weight shall be provided for each silencer. The exhaust system shall be mounted inside genset enclosure.

2.5 AUTOMATIC STARTING SYSTEM

- A. A DC electric starting system with positive engagement shall be furnished. The starting motor voltage shall be as recommended by the engine Manufacturer.
- B. An engine control shall be furnished as an integral part of the electric set to start and stop the engine as signaled by the automatic transfer controls on the generator control unit. The control shall start the engine by adjustable timed cranking cycles for a total period of not less than one minute. The crank and rest cycles shall be individually adjustable. The starting circuit shall open, and the control shall activate an alarm circuit if the engine does not start. The control shall be equipped with automatic safety shutdowns so that upon signal of a low oil pressure, high water temperature, or overspeed condition of the engine, the control shall immediately stop the engine. The control shall be equipped with digital display to indicate any of the engine failures and also with a 3-position control switch identified for "automatic-off-manual" externally mounted.
- C. Engine Cranking Batteries: The batteries shall be of the lead acid type, and shall be of domestic manufacture. The battery shall be rated S.A.E. type "D", diesel engine starting type and of sufficient size and capacity in a fully charged condition to crank start the engine generator for the maximum allowed crank cycle, (minimum 20-second cranking periods) six consecutive times at 20 degrees F with out recharging between cranks. The batteries shall be mounted in suitable covered racks. Battery rack location will be as shown on the Shop Drawings.
- D. Battery Chargers:
 - 1. Provide a 10amp battery charger. Chargers shall be UL 1236-BBHH listed and CSA or CUL certified for use in emergency applications. The charger shall be compliant with UL991 requirements for vibration resistance.
 - 2. The charger shall be capable of charging a fully discharged battery without damage to the charger. It shall be capable of returning a fully discharged battery to fully charged condition within 24 hours. The charger shall be UL-labeled with the maximum battery amp-hour rating that can be recharged within 24 hours.
 - 3. The charger shall incorporate a 4-state charging algorithm, to provide trickle charge rate to restore fully discharged batteries, a bulk charge rate to provide fastest possible recharge after normal discharge, an absorption state to return the battery to 100 percent of charge, and a float stage to maintain a fully charge battery and supply battery loads when the generator set is not operating. In addition, the charger shall include an equalization timer. Charge rates shall be temperature compensated based on the temperature directly sensed at the battery.
 - 4. The DC output voltage regulation shall be within plus or minus 1%. The DC output ripple current shall not exceed 1 amp at rated output current level.
 - 5. The charger shall include the following features:

- a) Two line alphanumeric display with programming keys to allow display of DC output ammeter and voltmeters (5% accuracy or better), display alarm messages, and perform programming;
- b) LED indicating lamp(s) to indicating normal charging condition (green), equalize charge state (amber), and fault condition (red);
- c) AC input overcurrent, over voltage, and undervoltage protection;
- d) DC output overcurrent protection;
- e) Alarm output relay;

2.6 ALTERNATOR, EXCITER AND ACCESSORIES

- A. Rating: The alternator shall be rated as shown 1800 RPM 3 phase, 60 Hertz, 277/480 volts, at a maximum temperature rise of 80 degrees C (both armature and field) by resistance at full rated load in ambient air of 40 degrees C. The alternator shall be wound for 2/3rds pitch for harmonic mitigation. The alternator shall conform to NEMA Standard MG-1. As an alternate to the 80 degree C rise alternator
- B. Performance: The instantaneous voltage dip shall not exceed 25 percent of rated voltage when full load, at rated power factor, is suddenly applied. Recovery of stable operation shall occur within 1 second. Steady state modulation shall not exceed +/- 1/2 percent. Provide documentation of submitted unit meeting performance criteria with shop drawing submittals.
- C. The alternator shall be capable of starting across the line the maximum HP motors shown that are 85% efficient with a power factor of 0.8 in equal steps with no more than 10% instantaneous voltage dip and 2% frequency dip. Provide documentation of submitted unit meeting performance criteria with shop drawing submittals.
- D. Construction:
 - 1. The alternator and exciter shall be dripproof, with split sleeve, or ball race bearings. A shaft-mounted brushless exciter shall be a part of the assembly. The stator core shall be built up of high grade silicon steel laminations precision punched, and individually insulated. Armature lamination followers and frame ribs shall be welded integral with the frames for support of the stator core. A directional blower shall be mounted on the unit to draw cooling air from the exciter and over the rotor poles and through louvered openings on the opposite end.
 - 2. The exciter shall be a fast response type, with a rotating 3-phase full-wave bridge. The exciter shall have a low time constant and large capacity to minimize voltage transients under severe load changes.
 - 3. Alternator stator and exciter stator windings shall be a full Class H insulated system (generator rated for class B temperature rise of 80 degrees) vacuum impregnated with epoxy resin which after curing shall have additional treatment of epoxy for resistance to an environment of moisture and salt air.
 - 4. Alternator rotor poles shall be built up of individually insulated silicon steel punchings. Poles shall be wound and bonded with high strength epoxy resin. Cage connections to the amortisseur rings shall be brazed for strong construction and permanent electrical characteristics. Each pole shall be securely bolted to the rotor shaft with bolts sized for the centrifugal forces on the rotor. Alternator

windings shall be braced for full line to ground fault currents, on a solid grounded neutral system.

E. Accessories and Attachments

1. Terminal boxes: The unit shall contain a controls terminal box properly sized and provided with terminal strips and interposing relays and devices to properly interface genset controls with remote controls and instrumentation. The generator shall have separate AC and DC low voltage terminal boxes with suitably marked terminal strip for required connections.
2. All required P.T.'s, C.T.'s and protective relays shall be supplied by the engine-generator Manufacturer.
3. Vibration isolation: Provide vibration isolation.
4. Provide a molded case line circuit breaker. Provide breaker with solid state adjustable functions for long time, and instantaneous trip. Instantaneous adjustment trip setting range 2-10 or greater. Provide line circuit breaker with a 100% continuous current rating.

F. Generator Associated Controls:

1. Voltage Regulator: The generator Manufacturer shall furnish a hermetically sealed, silicon controlled rectifier type voltage regulator employing a zener reference with a plus or minus one percent regulation for the generator. The regulator shall include 3 phase voltage sensing, automatic short circuit protection and shall include automatic underfrequency protection to allow the generator to operate at no load at less than synchronous speed for engine start-up and shutdown procedures. Switches and/or fuses shall not be used to provide this protection. An over-voltage sensing module with manual reset shall be furnished with the regulator. A volts per Hz., sensing module shall be provided as part of the regulation system. A voltage adjustment rheostat for 5 percent voltage adjustment on the unit shall be provided.
2. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at 300% of rated current for not more than 10 seconds.

2.7 GENERATOR SET INSTRUMENTATION

A. The generator set shall be provided with a microprocessor-based control system which is designed to provide automatic starting, monitoring, and control functions, both local and remote, for the generator set. The control shall be mounted on the generator set. Controls shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered. The control shall be UL508 listed, and meet IEC8528 part 4. All switches, lamps, and meters shall be oil-tight and dust-tight, and the enclosure door shall be gasketed. The entire control shall be tested and meet the requirements of IEEE-587 for voltage surge resistance.

B. The front display of the genset control panel unit shall include the following:

1. 1% accuracy generator set AC output instruments; Ammeter, Voltmeter, Frequency Meter, Wattmeter, KW-hour meter, Power Factor Meter. Selector switches to allow viewing of voltage and amperes for each phase shall be provided. For 3-phase/4-wire systems the voltmeter shall indicate line to line and line to neutral conditions. Running Time Meter and Start Counter.
2. Generator Set Mode Selector Switch: Switch shall provide run, off, and automatic functions for control of the generator set.
3. Control Reset push-button switch with indicating lamp. Lamp shall flash to indicate that generator set is locked out due to a fault condition.
4. Lamp test push-button switch. Operation of this switch shall cause all lamps on the panel to be simultaneously tested.
5. Emergency Stop switch. The emergency stop switch shall be a red, mushroom head switch which maintains it's position until manually reset. Install switch external to genset enclosure at entrance door.
6. Precision voltage and frequency adjust raise/lower switches. Switches shall allow the generator set frequency and voltage to be adjusted plus or minus 5% when the generator set is operating independently of the system bus. Voltage and frequency adjustment switches shall be located adjacent to the generator set and bus metering, for ease of use by the operator.
7. Provide an alarm and status indicating panel to indicate the genset conditions to the operator via LED display; provide the following alarm condition indicators:
 - Low DC Voltage
 - High DC Voltage
 - Weak Battery
 - Low Oil Pressure Alarm
 - Low Fuel - main tank
 - Fuel tank leak
 - High Engine Temp Alarm Amber
 - Ground Fault
 - Overcurrent Alarm
6. The alarm and status indicating panel shall indicate the following genset shutdown conditions to the operator:
 - Breaker Failure
 - Not in Auto
 - High Engine Temp
 - Low Oil Pressure
 - Overcurrent
 - Short Circuit
 - Loss of Excitation
 - Reverse Power
 - Overcrank
 - Overspeed
 - Under Frequency
 - Under Voltage
 - Over Voltage
 - Low Coolant Level

7. The alarm and status indicating panel shall indicate the following genset status conditions to the operator:
Genset Ready (in auto and ready)
Generator Running (ready to load)
8. In addition, provisions shall be made for indication of three (3) customer-specified alarm or shutdown conditions.

2.9 SUB-BASE FUEL TANK (existing)

- A. The contractor shall provide tank testing after installation and before placing in service per NFPA30. 21.5.2.4 Horizontal shop-fabricated aboveground interstice and primary -tanks shall be tested for tightness with air pressure at not less than a gauge pressure of 3 psi and not more than a gauge pressure of 5 psi. The pressure shall be held for not less than 1 hour or for the duration specified in the listing for the tank.
- B. Contractor to provide a specialty firm to clean tank prior to genset removal. Provide water and biological debris removal from existing fuel within tank via biocide treatment. Provide a 1 micron filter and fuel polishing water separator until cleaning is complete. Remove cleaned existing fuel from main tank. Provide fuel analysis and fuel filter debris analysis before and after cleaning is complete. A borescope inspection of the tank shall be performed by a certified tank contractor and a condition report filed with the owner. All tank testing and reports filed with the owner prior to installation of the genset on the tank.

PART 3 - EXECUTION

3.0 SERVICES

- A. Furnish the services of a competent and experienced Manufacturer's field service technician who has complete knowledge of proper operation and maintenance of the equipment to inspect the installed equipment, supervise the initial test run, coordinate checkout of the interlocks between ATS and the Genset and to provide instructions to the plant personnel. The first visit will be for checking and inspecting the equipment after it is installed.
- B. Provide instruction of plant personnel in operation and maintenance of the equipment. This instruction period shall be scheduled at least ten days in advance with the Owner and shall take place prior to final acceptance and after substantial completion by the Owner.
- C. The final copies of operation and maintenance manuals specified in division 1 Sections must be delivered to the Engineer prior to scheduling the instruction period with the Owner.
- D. The distributor of the Genset shall provide installation coordination services to insure a properly installed and coordinated system including all coordination with the electrical and instrumentation contractor for proper interfacing. As a minimum the Genset Distributor shall coordinate the installation with factory trained technicians with weekly site visits from the time the genset arrives on site to the time it is fully operational.

3.1 INSTALLATION

- A. The genset installer shall install suitable jacket water additives as furnished by the engine Manufacturer and approved by the Engineer, for prevention of both scale formation and corrosion in the water jackets and cooling system components which are in contact with the engine jacket water. These additives shall be added to the cooling system prior to running the field acceptance test.
- B. The Contractor shall install the complete exhaust system, together with the silencer, the piping and insulation, and the complete supporting system. Where the exhaust passes through the roof or side wall, furnish and install suitable thimble and "rain skirt".
- C. The engine generator set and associated equipment shall be shop primed and finish coated in accordance with the Manufacturer's standard practice prior to shipment. An adequate supply of touch-up paint shall be supplied by the Manufacturer.

3.2 TESTING

- A. The engine-generator set shall be given the Manufacturer's standard load bank test at full rated load and power factor at the factory.
- B. Prior to final acceptance of the generator set, all equipment furnished under this Section shall be field tested to show it is free of any defects and that the generator set can operate satisfactorily under full load test using resistance type load banks. The genset testing shall be for four (4) continuous hours. Any defects which become evident at this time shall be corrected before acceptance.
- C. During the field tests, readings will be taken at thirty (30) minute intervals of the following: oil temperature, exhaust temperature, water temperature, volts, amps, frequency, fuel pressure, manifold pressure, and oil pressure, KW, KWH.
- D. The owner shall provide fuel for start-up and testing of the generator system.

3.3 WARRANTY

- A. The complete electrical standby power system; generator set, controls, and associated switches, and accessories, as provided by the factory distributor including the ancillary equipment shall be warranted by the manufacturer against defects in materials and workmanship for a period of five years or 1500 genset run hours, whichever occurs first from the date of system startup. Coverage shall include parts, labor, travel expenses and labor to remove and reinstall defective equipment under terms of the Manufacturer's comprehensive standard warranty. No deductibles shall be applied to the warranty except for starting batteries and water jacket heater being warranted for one year.

END OF SECTION