

# CLAREMORE

## ENGINEERING

### PROJECT ADDENDUM

Bid / RFP / RFQ Number: SB-2023-1

Project Number: E2021-007

Project Name: Oakwood Lift Station Upgrades

Addendum No.: 1

Date of Addendum: February 1, 2023

To All Plan Holders:

Please note the following changes and/or clarifications:

1. PRE-BID MEETING ALTERNATE DATE:

An alternate pre-bid meeting date is being provided: **FEBURARY 6<sup>TH</sup> @ 2:00pm**. Meeting location to remain the same. Any Contractor bidding as a Prime must attend one of the pre-bid meetings to be eligible to bid. If you attended the pre-bid meeting on January 30<sup>th</sup>, you are not required to attend this meeting.

2. LIFT STATION INFORMATION:

- Flowrate: 90,000 Gallons per Day, average 65 pump cycles per day.
- Pump Parameters (estimated): 450 GPM @ 50 PSI.
- Pump Setpoints: ON: 4.9-FT OFF:1.2-FT
- Wetwell ID: 8-FT

**3. LIFT STATION STEP REMOVAL:**

As part of Add Alternate #1, the steps in the lift station shall be removed before the interior is coated. Any holes shall be grout filled prior to coating application.

**4. ELECTRICAL SPECIFICATIONS:**

Attached to this addendum are the electrical specifications (80 pages) for the electrical portion of the project. They were omitted from the original bid packet.

*All other terms, conditions and specifications remain unchanged. Any additions made to the Bidding and Contract Documents including the Plans and Specifications per this Addendum shall be considered a part of the original Bidding and Contract Documents. The professional seals and signatures applied to the original Bidding and Contract Documents are thereby considered to cover any additions to said documents per this Addendum.*



\_\_\_\_\_  
Levi P. Hix, P.E.  
Engineering Project Manager

\_\_\_\_\_  
2/1/23

Date

*Bidders shall acknowledge receipt of this Addendum in the space provided in the Bid Proposal Form.*

# PROJECT MANUAL

## City of Claremore

### Oakwood Lift Station Upgrade Project

PROJECT NO. 218243-004

PREPARED BY

PROFESSIONAL ENGINEERING CONSULTANTS, PA  
303 South Topeka, Wichita, Kansas 67202  
316-262-2691 / [www.pec1.com](http://www.pec1.com)

**SEPTEMBER 2022**

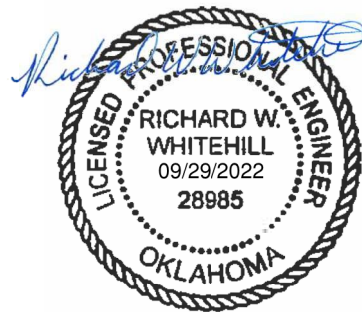
# CITY OF CLAREMORE

## Oakwood Lift Station Upgrade Project

PEC Project No. 218243-004

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SECTION 260500 –COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 GENERAL CONDITIONS:

- A. The General Conditions, Supplementary General Conditions, General Requirements, and Special Conditions shall be and are hereby made a part of this Section of the specifications.
- B. In case of conflicts between the electrical drawings and Division 26 of these specifications, the more stringent requirements shall govern. In all cases, notify the Engineer for direction.
- C. The requirements of COMMON WORK RESULTS FOR ELECTRICAL establish minimum requirements, apply to, and are hereby made a part of all sections of Division 26 of this specification.
- D. The Contractor shall be responsible for excavation of all earth, soil, and rock conditions at the site. Review the elevations and soil boring logs and include all associated costs.

1.2 DESCRIPTION:

- A. The electrical work shall include all labor, materials, tools, transportation, equipment, services, and facilities, required for the complete, proper, and substantial installation of all electrical work shown on the plans, and/or outlined in these specifications. The installation shall include all materials, appliances, and apparatus not specifically mentioned herein or noted on the drawings, but which are necessary to make a complete working installation of all electrical systems.
- B. All of the electrical related work required for this project (unless specified otherwise) is a part of the Electrical Contract price but is not necessarily specified under this division of the specifications or shown on the electrical drawings. Therefore, all divisions of the specifications and all drawings shall be consulted.
- C. The plan drawings are schematic only and are not intended to show the exact routing of raceway systems unless dimensions are noted on the drawings. Final routing will be governed by field conditions (structural members, mechanical equipment, ductwork, underground piping, duct banks, etc.) and shall be determined by the Contractor and approved by the Engineer. Any changes in routing shall not change the design of the raceway system.
- D. The plan drawings showing device and equipment locations are schematic only and are not intended to show exact locations unless dimensions are noted on the drawings. The Contractor shall review all contract drawings that may affect the location of devices and equipment to avoid possible interference and permit full coordination of all work. The right to make any reasonable change in location within 6'-0", is reserved by the Engineer up until the time of rough-in at no extra cost.
- E. Furnish and install electrical wiring, systems, equipment, and accessories in accordance with the specifications and drawings. Cable, panelboards, and other items, arrangement for specified items in general are shown on drawings.

- F. Electrical service entrance equipment (arrangements for temporary and permanent connections to the power company's system) shall conform to the power company's requirements. Coordinate fuses, circuit breakers and relays with the power company's system, and obtain power company approval. Provide all required temporary building power and lighting. Remove when finished. Installation of temporary power and lighting shall comply with N.E.C. and OSHA requirements.
- G. Ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways accordingly sized.

### 1.3 MINIMUM REQUIREMENTS:

- A. Codes Rules and Regulations: Execute all work under ADA, the latest rules, and regulations of the National Electrical Code (NEC), the National Fire Protection Association, and with all laws, regulations and ordinances of the County, State, City, and the Utility Company.
- B. Codes shall govern in case of any direct conflict between codes, plans and specifications; except when plans and specifications require higher standards than those required by code. Variance from the plan and specifications made to comply with code must be approved by the Engineer. If approved, they shall be made with no increased cost to the Owner.

### 1.4 STANDARDS:

- A. All material and equipment shall be listed, labeled, or certified by UL LLC, where such standards have been established. Equipment and material which are not covered by UL Standards will be accepted provided equipment and material is listed, labeled, certified, or otherwise determined to meet safety requirements of a nationally recognized testing laboratory. Equipment of a class which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as NEMA, or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.
- B. Definitions:
  - 1. Certified: Equipment is "certified" if:
    - a. Equipment has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards, or to be safe for use in a specified manner.
    - b. Production is periodically inspected by a nationally recognized testing laboratory.
    - c. It bears a label, tag, or other record of certification.
  - 2. Nationally recognized testing laboratory: A testing laboratory, which is approved, in accordance with OSHA regulations, by the Secretary of Labor.

1.5 QUALIFICATIONS (PRODUCTS AND SERVICES):

- A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- B. Product Qualification:
  - 1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
  - 2. The Engineer reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.
- C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will respond within //two// hours of receipt of notification that service is needed. Submit name and address of service organization.

1.6 MANUFACTURED PRODUCTS:

- A. Materials and equipment furnished shall be new, of best quality and design, free from defects, of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts should be available. All items used on this project shall be free of asbestos, PCB, and mercury material.
- B. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer.
- C. Equipment Assemblies and Components:
  - 1. Components of an assembled unit need not be products of the same manufacturer unless indicated otherwise.
  - 2. Manufacturers of equipment assemblies, which include components made by others, shall be completely responsible for the final assembled unit.
  - 3. Components shall be compatible with each other and with the total assembly for the intended service.
  - 4. Constituent parts which are similar shall be the product of a single manufacturer.
- D. Factory and Field wiring shall be identified on the equipment being furnished and on all wiring diagrams.
- E. When Factory Testing is Specified:
  - 1. The Engineer shall have the option of witnessing factory tests. The Contractor shall notify the Engineer a minimum of 15 working days prior to the manufacturer making the factory tests.
  - 2. Four copies of certified test reports containing all test data shall be furnished to the Engineer prior to final inspection and not more than 90 days after completion of the tests.
  - 3. When equipment fails to meet factory test and reinspection is required, the Contractor shall be liable for all additional expenses, including expenses of the Engineer.

1.7 EQUIPMENT PROTECTION:

- A. Equipment and material shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain.
- B. During installation, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of foreign matter and be vacuum cleaned both inside and outside before testing, operating, and painting.
- C. Damaged equipment shall be, as determined by the Engineer, placed in satisfactory operating condition, or be returned to the source of supply for repair or replacement.
- D. Painted surfaces shall be protected with factory installed removable heavy Kraft paper, sheet vinyl or equal.
- E. Damaged paint on equipment and materials shall be restored to the original quality of paint and workmanship as used by the manufacturer so repaired area is not obvious.

1.8 GENERAL WORK REQUIREMENTS:

- A. Arrange, phase and perform work to assure electrical service both temporary and permanent for buildings at all times.
- B. Coordinate location of equipment and conduit with other trades to minimize interferences.
- C. Examination of Site:
  - 1. Visit the site, inspect the existing conditions, and check the drawings and specifications so as to be fully informed of the requirements for completion of the work.
  - 2. Lack of such information shall not justify an extra to the contract price.
- D. Permits:
  - 1. Obtain and pay for all licenses and permits, fees, inspection and certificates required for the execution of this work.
  - 2. Pay fees and charges for connection to outside services and use of property.
  - 3. Deliver permits and certificates to the Engineer to be transmitted to the Owner.
- E. Services:
  - 1. This Contractor shall pay for all expenses, deposits, reimbursements, etc., required by the local rules and codes for the service to the buildings, complete and ready for use. See plot plan.
  - 2. Consult Power Company for their requirements and for coordinating with their installation. Contractor shall provide any work thus required beyond that indicated by the drawings and specifications. He shall bear all expense involved for the complete installation of the electrical service (both temporary and permanent) to the building ready for operation, including utility service charges, except as specifically excluded on the plans.



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3. This Contractor shall consult all local departments to verify requirements and bid installation of service in accordance with local codes and Utility company rules and regulations.
4. This Contractor shall bear all expense involved for the complete telephone service conduit installation and pull wire ready for cable installation. Verify complete installation with the local telephone company and bid installation to comply with their requirements.

F. Responsibility:

1. This Contractor will be held responsible for any and all damage to any part of the building or to the work of other contractors, as may be caused through this contractor's operation.
2. Any mutilation of building finishes or equipment initiated by electrical construction shall be properly corrected by the respective finishing contractor and paid for by the Electrical Contractor.
3. The operation of the temporary power and the permanent electrical system shall be the responsibility of this Contractor until acceptance of the building by the Owner.

G. Work to be done by General Contractor:

1. Build in all openings, sleeves, chases, etc., for conduit and equipment as established, furnished, and set by this Contractor. The General Contractor shall seal or grout all openings after this Contractor has installed the conduits.
2. Build in bolts, brackets, hangers etc., for work established, furnished and set by this Contractor.
3. All concrete work required for equipment furnished and set by this Contractor including clean up pads under electrical gear, fixture bases, transformer bases, etc.
4. Painting: All painting of electrical equipment installed in finished areas shall be done by the General Contractor. Painting will not be required on receptacles, switches, circuit breakers etc. All fixtures and exterior poles specified to be factory-primed shall be painted by General Contractor. Paint all wiremold, exposed conduit and equipment, etc., to match final wall colors.
5. Provide fireproofing above fixtures located in fire rated ceilings per U.L. requirements.
6. Pay all utility costs for operation of electrical system during construction until acceptance of building by the Owner.

H. Work done by the Mechanical Contractor:

1. The Mechanical Contractor shall furnish wiring diagrams and temperature control drawings of all equipment furnished to the Electrical Contractor. (Catalog information is unacceptable, provide point to point drawings.)
2. The Mechanical Contractor shall furnish and install all control equipment requiring connections to air, water, steam, etc., such as pneumatic electric relays, remote bulb temperature controls, solenoid valves, aquastats and pressure controls.
3. The Mechanical Contractor shall reimburse the Electrical Contractor for any changes in system design i.e., control or equipment which affects the Electrical Contractor. Also refer to equipment connections, controls, and instrumentation in 260500.

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I. Workmanship and Coordination:

1. Make installation substantially as shown on the plans.
2. Make alterations in location of apparatus or conduit as may be required to conform to building construction without extra charge.
3. Mechanical equipment service clearances and electrical apparatus service clearances as specified in their respective manufacturer's product data shall be maintained free from conduit.
4. Cooperate with other trades in their installation of work.
5. Complete the installation in a workmanlike manner, completely connected and ready to give proper and continuous service.
6. Use only experienced licensed electricians.

J. Cutting and Patching:

1. Notify the General Contractor in ample time, of the location of all chases, sleeves, and other openings required in connection with the work of this contract.
2. Cutting and patching made necessary because of failure to comply with the above shall be done by the General Contractor at the expense of the Electrical Contractor.
3. When it is necessary for the Electrical Contractor to cut building materials, it shall be done in a neat and workmanlike manner meeting with the approval of the Engineer.
4. Holes through concrete shall be carefully drilled with a "Concrete Termite" drill. A Star Drill or Air Hammer will not be permitted. Structural members shall not be cut without approval from the Engineer.
5. Any penetrations thru the roof shall be made with "Stoneman" 900 Series flashing connections as manufactured by Elmdor/Stoneman, City of Industry, California, or as approved by the Engineer.
6. Any penetrations made in exterior or basement foundation walls shall be sealed with Thunderline "Link-Seal" connections, as manufactured by Thunderline Corporation, Wayne, Michigan.

K. Manufacturer's Instructions:

1. Apply, install, connect, erect, use, clean, and condition articles, materials and equipment as directed by the manufacturer.

L. Provide separate support for all devices mounted in or to lay-in ceiling tile. Ceiling tile shall not be used to support any device.

1.9 EQUIPMENT INSTALLATION AND REQUIREMENTS:

A. Equipment location shall be as close as practical to locations shown on the drawings.

B. Working spaces shall not be less than specified in the National Electrical Code for all voltages specified.

C. Inaccessible Equipment:

1. Where the Engineer determines that the Contractor has installed equipment without proper clearances or not conveniently accessible for operation and

maintenance, equipment shall be removed and reinstalled as directed at no additional cost to the Owner.

a. Install access panels as approved by the Engineer to provide access to all equipment, J-boxes and outlets located in non-accessible spaces. Panels shall be flush locking type with a fire rating equal to the ceiling system.

2. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping, and ductwork. Outlet and box covers shall be removable by using regular length (8") screw drivers.

D. Distribution Equipment:

1. All items of Electrical Distribution Equipment (switchboards - panelboards - disconnects) shall be of one manufacturer, unless specifically noted on the drawings, in the specifications, or approved by the Engineer. Intermixing of distribution equipment by different manufacturers will not be permitted.

2. Provide a Type 1 surge protective device for lightning protection on each service entrance for each building. The surge protective device shall meet the requirements of UL 1449. Refer to drawings for voltage and phasing of service. Arrester shall be located within the main switch, panel or switchboard enclosure and connected with 12" maximum leads. Surge protective devices shall have an enclosure suitable for indoor or outdoor mounting and shall utilize metal oxide varistors that are individually fused.

a. 208Y/120V: Maximum Voltage Protection Ratings shall be 700V L-N and 1200V L-L. Minimum MCOV rating shall be 180V L-N and 360V L-L, minimum nominal discharge current shall be 10,000A, minimum short circuit current rating shall be 200,000A, and minimum surge current rating shall be 40,000A. Square 'D' #SDSA2040 or approved equal.

3. Equipment layouts on the drawings are based on one manufacturer. Verify all actual equipment sizes with equipment manufacturer prior to bidding.

4. If layout changes are required due to differing electrical manufacturer's equipment size, they must be submitted to and approved by the Engineer. National Electric Code working clearances must be maintained at all times. Extra remuneration will not be allowed for layout changes that differ from those shown.

5. Provide and install all steel supports as required for mounting of electrical equipment.

6. Anchor all free standing electrical equipment including switchboards, switchgear, substations, motor control centers, paralleling gear, transfer switches, transformers, etc. to the floor with plated, 1/2" diameter minimum, anchor bolts or as recommended by the manufacturer.

1.10 EQUIPMENT CONNECTIONS, CONTROLS AND INSTRUMENTATION:

A. General: The following applies to all electrical power and control connections for all equipment requiring electrical installation work provided by others.

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- B. Electrical Contractor shall install and connect the following items for equipment requiring electrical power that is either furnished or specified by other Contractors and/or the Owner. Where these required items are not furnished with the equipment being connected, it shall be the Electrical Contractors responsibility to provide the necessary items including conduit, boxes and wiring.
1. Starters
  2. Disconnecting Devices
  3. Thermal Overload Devices
  4. Overcurrent Devices
  5. Short Circuit Protective Devices
  6. Power Factor Correction Devices
  7. Control Devices (Local and Remote)
  8. Audible and Visual Control Status Annunciation Devices
  9. Equipment Mounting Structures
  10. Additional Miscellaneous Devices
- C. In general, all major equipment will be specified to be factory prewired with only service and interconnecting wiring required at the site by the electrical contractor; however, the Electrical Contractor shall check all divisions of the specification to verify if the equipment is specified factory prewired and if not, then it shall be the responsibility of the Electrical Contractor to provide the complete wiring of the equipment in accordance with wiring diagrams provided by other contractors and/or Owner to the Electrical Contractor. All interconnecting of equipment shall be by the Electrical Contractor.
- D. All line and low voltage wiring and connections required to control the equipment are a part of this section. All wiring shall be in conduit. All conduit, wiring, and terminations shall be provided by the Electrical Contractor.
- E. The Electrical Contractor shall provide 120 volt control power supply; #12 Ga. CU. THHN/THWN in 1/2"C. minimum at all points required by controls, instrumentation and sprinkler risers. Circuit as shown on the plans or to the nearest 120 volt panel if no circuiting is indicated. Use spare 20 Amp. breakers. Each control panel shall be on a separate circuit unless otherwise indicated. If the controlled equipment is fed from the emergency system, then the control power supply must feed from the emergency system.
- F. The Contractor shall become familiar with the equipment to be furnished by the other Contractors and/or the Owner in connection with this work and include provisions for such connections and work in the Contractor's price. Extra remuneration will not be allowed for such work.
- G. Connections to all equipment have been designed from units as specified on the drawings or in the specifications. In the event equipment or control differs on approved shop drawings it shall be the responsibility of the Supplying Contractor to coordinate electrical connections to the units and reimburse Electrical Contractor for any changes in system design. These changes shall not involve additional cost to the Owner.
- H. Review all plans and specifications to verify all equipment connections that are required by mechanical and/or other contractors. Although the electrical drawings will show equipment connection requirements, it is the Electrical Contractor's responsibility to connect all equipment furnished by other Contractor's at no extra cost to the Owner, even

if this equipment connection is not shown on the electrical drawings. Coordinate all required connections not shown on the electrical drawings with the Engineer.

1.11 NAMEPLATES:

- A. General: The following items shall be equipped with nameplates:
  - 1. Disconnect switches (fused or nonfused), panelboards, , starters, contactors, relays, junction boxes and pull boxes.
- B. Inscription: Nameplates shall adequately describe the function or use of the particular equipment involved. Nameplates for panelboards and switchboards shall include the panel designation, voltage, and phase, A.I.C. rating of the supply (see schedules, one-line diagram, and color coding). For example, "Panel A" 120/208 V, 3-Phase, 4-Wire, 10,000 A.I.C. or "50,000 AIC with 22 KA Breakers, Series with class 'J' Fuses":
  - 1. Phase A - Black
  - 2. Phase B - Red
  - 3. Phase C - Blue
  - 4. Neutral - White
  - 5. Ground - Green
- C. The name used for a machine nameplate shall be the same as the one used on the machine's motor starter, disconnect and P.B. station nameplates. Nameplates for fused switches and panels shall also indicate fuse type and size.
  - 1. In addition to the instructions listed above:
    - a. All panelboards and transfer switches fed from the emergency system shall be labeled "Emergency System".
- D. Construction:
  - 1. Nameplates shall be as follows:
    - a. Normal power - laminated phenolic plastic white front and back with black core.
    - b. Emergency System - laminated phenolic plastic red front and back with white core.
  - 1. Lettering shall be engraved through front layer to form 1/4" characters. Nameplates shall be securely fastened to the equipment to be identified, with No. 4 Phillips, round head, cadmium plated, steel self tapping screws or nickel plated brass bolts. Motor nameplate may be nonferrous metal not less than 0.03 inches thick, die stamped. In lieu of separate plastic nameplates, engraving directly on device plates is acceptable. Letters engraved thus, shall be filled with contrasting enamel. All nameplates and their installation are part of this work. Free hand lettering or dymo label marker will not be acceptable.

1.12 MATERIALS OF APPROVED EQUAL:

- A. Where items of equipment and/or materials are specifically identified herein by a manufacturer's name, model or catalog number, and only such specific items may be used in the base bid, except as hereinafter provided.
- B. Unless requests for changes in base bid specifications are received, approved and noted by written addendum prior to the opening of bids, the successful contractor will be held to furnish specified items.
- C. After contract is awarded, changes in specifications shall be made only as defined under "Substitution of Equipment".

1.13 SUBSTITUTION OF EQUIPMENT:

- A. After execution of the contract, substitution of equipment of makes other than those specifically named in the contract documents, may be approved by the Engineer, only if the equipment named in the specifications cannot be delivered to the job in time to complete the work in proper sequence and due to conditions beyond control of the Contractor. Provide documentary proof in writing from the manufacturer that the specified equipment will not be available in time. If the Contractor is responsible for the delay, the substitution will not be approved.
- B. Requests for substitutions must be accompanied by documentary proof of equality or difference in price and delivery, if any, in form of certified quotations from suppliers of both specified and proposed equipment.

1.14 SUBMITTALS: IN ACCORDANCE WITH SECTION SAMPLES AND SHOP DRAWINGS, FURNISH THE FOLLOWING:

- A. The Engineer's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.
- B. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Engineer to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- C. Submittals shall be complete and submitted together for each section. Individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assemble as a whole. Partial submittals will not be considered for approval.
  - 1. Mark the submittals, "SUBMITTED UNDER SECTION\_\_\_\_\_". Mark out all statements on sheets that do not apply otherwise. The Engineer may select options and equipment not originally specified. All options that are not marked out will be assumed that the Contractor will furnish the same.
  - 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
  - 3. Submit each section separately.

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4. Mark catalog cuts to indicate equipment, capacities, finishes, sizes, etc. Each individual item shall have its own sheet provided for approval. (Example: Separate sheets for each panelboard.)
- D. The submittals shall include the following:
1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
  2. Elementary and interconnection wiring diagrams for communication and signal systems, control system and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
  3. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
  4. Quantities of materials will not be verified by the Engineer. Approval stamp on shop drawings does not constitute approval of quantities listed on shop drawings.
  5. Shop drawings:
    - a. All shop drawings shall be checked and signed by this contractor and general contractor prior to submittal to the Engineer.
    - b. Shop drawings submitted without Contractor's signatures or approval and verification will not be approved.
    - c. Shop drawings shall be submitted on, devices, lighting fixtures (including distribution curves), motor starters, panelboards, disconnects, , raceway systems, low-voltage systems, etc.
  6. Each sheet shall be either 8 1/2" x 11"; 8 1/2" x 13"; or 11" x 17" bond with a 5" x 3" clear area for engineer's stamp. (This area shall not be used by this contractor or the general contractor's stamp.) Larger drawings shall be able to be blue printed.
  7. Submittals for low-voltage systems (, controls, , etc.) shall include complete riser diagrams showing all conductors and conduit sizes.
- E. Engineer's acceptance of Compliance Submittals will not relieve the Contractor from his responsibility for any deviations from the requirements of the contract documents, unless Contractor has in writing called Engineer's attention to such deviation at the time of submission and the Engineer has given written approval to the specific deviation; nor shall any acceptance by Engineer relieve Contractor from responsibility for errors or omissions in Compliance Submittals.
- F. Quantity of Submittals: See the general specification sections.
- 1.15 ELECTRICAL WORK COMPLETION:
- A. Before requesting final inspection the following work must be completed.

B. Operating Instructions:

1. The Contractor shall submit along with the shop drawings of the equipment, three (3) copies of operating instructions for all items. Instructions shall be prepared by the manufacturer of the equipment.
2. After the operating instructions have been approved by the Engineer, the Contractor shall include the three (3) copies in maintenance instructions brochures.
3. The Contractor shall also obtain all manufacturers' instructions, manuals, and one complete set of drawings and turn these over to the Engineer at the completion of the project.
4. The Contractor shall keep in a safe place; all keys and special wrenches furnished with equipment under this contract and shall give same to the Engineer at the completion of the project.
5. The Contractor shall prepare a complete brochure, in triplicate, covering all systems and equipment furnished and installed under his contract. Brochures shall be submitted to the Engineer for approval and delivery to the Owner. The cost of this brochure shall be included in the contract cost. Brochures shall contain the following:
  - a. Certified equipment drawings and/or catalog data clearly marked for equipment furnished as required for approval submission under detailed section of the specifications.
  - b. Complete operating and maintenance instructions for each item of equipment.
  - c. Complete part list for each equipment item.
  - d. Any special special emergency operating instructions or a list of service organizations (including addresses and telephone numbers) capable of rendering emergency service to the various parts of the system.
6. Brochures shall be bound in hard backed three ring binders with an index, sub dividers and reinforced sheets.
  - a. Project name and address.
  - b. Section of work covered by brochure, i.e., "Electrical Work".
  - c. Name and address of Engineer.
  - d. Name and address of Contractor.
  - e. Telephone number of Contractor, including night or emergency number.
7. In addition to these written instructions, each respective Contractor shall fully and carefully instruct the Owner, or Owner's selected representatives, as to the proper operation, care and maintenance of each system and its equipment.

1.16 TESTING AND ADJUSTMENT:

- A. Record loads on each phase of all panelboards, distribution panels, switchboards, transformers and submit final readings to the Engineer for records. This Contractor shall adjust equipment, instruments, gages, meters etc., as required to test and adjust these systems.
- B. Check, test, and adjust the mechanisms of all electrical equipment and adjustable parts of lighting fixtures as required for optimum performance.



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- C. Perform tests for insulation resistance in accordance with the requirements of the National Electrical Code and insure that all circuits are free from short circuits.
- D. Keep a calibrated voltmeter and ammeter available at all times and provides service for test readings when and as required, up until the project is accepted by the Owner.
- E. Electrical Testing and Verification: Refer to the following specification sections (as applicable) for required tests and verifications:
  - 1. 260519 – Low Voltage Electrical Power Conductors and Cables
  - 2. 260526 – Grounding and Bonding for Electrical Systems
  - 3. 262416 – Panelboards
  - 4. 262726 – Wiring Devices
  - 5. 263213 – Gensets and Accessory Equipment
  - 6. 263600 – Automatic Transfer Switches

1.17 AS-BUILT DRAWINGS:

- A. Show on black or blue line prints in red ink all changes from original plans made during the installation. Return two (2) sets of red marked drawings, specifications and addenda, as set forth in the General Conditions, to the Engineer upon completion of the project.

1.18 FINAL INSPECTION:

- A. Final inspection will be made upon written request from the General contractor after the project is completed; in accordance with the Supplementary General Conditions.
- B. Furnish a workman familiar with this project to accompany the Engineer on final inspection and have available ladders, drop cords, and other equipment as required to gain access to any portion of this system.
- C. This Contractor and his principal subcontractors shall be represented at the inspection by a person of authority responsible to demonstrate to the engineer that his work conforms to the intent of the plans and specifications.
- D. Extra inspections made necessary by the Electrical Contractor's failure to comply with the conditions as set forth above shall be charged to the Contractor for the Inspector's time both on the job and spent in travel between the office and the project site.

1.19 GUARANTEE:

- A. Guarantee all work, material and equipment for a period of one year after date of substantial completion.
- B. During the one year guarantee period the Electrical Contractor shall be responsible for any defects which develop in the electrical systems. Upon notification of a defect by the General Contractor the Electrical Contractor shall make immediate effort to correct it and shall notify the Engineer when this work is completed. This guarantee does not include ordinary lamp failure.
- C. Repairs and/or replacements shall be made with no cost to Owner.

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- D. Provide as part of the work of this contract, in addition to the first year's guarantee on equipment and materials, the following routine maintenance and inspection. (The one year time period will not start until each item is completed in accordance with plans and specifications and accepted by the Owner). Correct and adjust all emergency systems, controls, fire alarm, transformer, etc. This service to be provided throughout the guarantee period.

1.20 SINGULAR NUMBER:

- A. Where any device or part of equipment is referred to in these specifications in the singular number (such as "the switch"), such reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

1.21 LOW-VOLTAGE SYSTEMS:

- A. Power wiring for low-voltage systems shall be furnished and installed by the contractor as shown on the drawings and as required by the equipment manufacturer.
- B. Low voltage outlets shall be installed as shown on the drawings and shall be as specified for voice outlets, hereinbefore, or as otherwise shown or required by the application or by the equipment manufacturer.
- C. Conduit for low-voltage systems other than nurse call, code blue, medical gas, and fire alarm shall be limited to the following and shall be furnished and installed by the Electrical Contractor.
  - 1. Conduit in walls, from outlets to accessible ceilings, terminated with open end bushing above ceiling.
  - 2. Conduits between floors, terminated with open end bushings.
  - 3. Conduits across fire and/or smoke walls, terminated with open end bushings, and sealed with approved fire rated material.
  - 4. Other conduits as shown on drawings.
- D. Conduits shall be sized as required by the number and type of conductors applied and/or as noted on plans (minimum 1") and shall be not smaller than sizes recommended by the equipment manufacturer. All conduits shall be labeled to identify which system it is to be used for i.e.: Fire Alarm, Nurse Call, Code Blue, P.A. etc.
- E. When ceiling voids are used as air return plenums, only U.L. Listed plenum cable shall be used or cables shall be completely routed in conduit.
- F. All low voltage wiring installed in ceiling voids shall be bundled, neatly routed, suspended above the grid system or located in cable tray and labeled with appropriate tags as to service.
- G. Low voltage wire and cable shall be specifically designed to function with equipment supplied. Cable shall be color coded for ease of installation and service, twisted, shielded, and grounded for control of voice circuits and covered with wear-resistant moisture proof protective insulation. Wire shall bear manufacturer's trademark either embossed or printed on cable.

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- H. Low-voltage systems shall be provided with a minimum of 20% spare capacity upon completion of the project unless otherwise noted.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 260500

## SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY:

- A. Section includes:
  - 1. Building wires and cables rated 600 VAC and less.
  - 2. Connectors, splices, and terminations rated 600 VAC and less.
  - 3. Wire lubricating compound.
  - 4. Control wiring.
  - 5. Communication and signal wiring.

#### 1.3 SUBMITTALS

- A. Product Data (Where indicated in Section "Common Work Results for Electrical", provide the following information): For each type of product indicated.

#### 1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended use.
- B. Comply with NFPA 70.
- C. Comply with NEMA WC 70.

### PART 2 - PRODUCTS

#### 2.1 CONDUCTORS AND CABLES (POWER AND LIGHTING):

- A. Conductors and Cables: NEMA WC 70, except as hereinafter specified.
  - 1. All conductors shown on plans are sized for copper.
  - 2. UL label required.
- B. Single Conductor:
  - 1. Soft annealed copper.
  - 2. Stranded for sizes No. 8 and larger. Solid or stranded for sizes No. 10 and smaller, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise.
  - 3. Minimum size No. 12, except where larger sizes are shown. (Size No. 14 minimum for controls).

- C. Stranding:
  - 1. Conductors between stationary and moving devices, such as hinged doors or panels, shall have Class H or Class K stranding. All other conductors shall have Class B or Class C stranding.
- D. Insulation:
  - 1. THHN-THWN, XHHW - Sizes No. 12 and larger.
- E. Metal Clad Cable (Type MC):
  - 1. Refer to 260519-2.1B for minimum conductor sizes.
  - 2. Metal Clad Cable shall be manufactured by AFC Cable Systems – Type MC steel or aluminum sheath or Southwire MC-AP.
  - 3. Metal Clad Cable shall be UL compliant for one, two and three hour wall penetration fire ratings. The cable shall have passed UL 1479 and meet NEC 300.22(C) for Environmental Air Handling spaces.
  - 4. Cable assembly shall include conductors with THHN insulation, an insulated ground conductor, a durable polypropylene assembly tape and an interlocked armor (galvanized steel or aluminum) outer jacket.

## 2.2 SPLICES AND JOINTS:

- A. In accordance with UL 486 A, B, D and NEC.
- B. Split-bolt type connectors are not allowed.
- C. Branch circuits (No. 10 and smaller):
  - 1. Connectors: Solderless, screw-on, reusable pressure cable type, 600 volt, 105 degree C. with integral insulation, approved for copper and aluminum conductors.
  - 2. The integral insulator shall have a skirt to completely cover the stripped wires.
  - 3. The number, size, and combination of conductors, as listed on the manufacturer's packaging shall be strictly complied with.
- D. Branch Circuits (No. 8 and No. 6):
  - 1. Connectors: Pre-insulated, mechanical, reusable cable type, 600 volt, 90 degree C. with integral insulation, approved for copper and aluminum conductors, cold temperature rated to -45 degree C. Connectors shall be equal to those manufactured by Polaris Connectors.
  - 2. Provide connectors rated for the location where installed.
  - 3. The number, size, and combination of conductors, as listed on the manufacturer's packaging shall be strictly complied with.
- E. Feeder Circuits:
  - 1. All feeder conductors shall be the same size and type and be continuous from the overcurrent device to the panel or equipment the feeder terminates at.

2. Connectors shall be indent type, UL listed for use with the size and type of wire installed of high conductivity and corrosion-resistant material. Do not install more than one conductor per connector unless the connector is UL listed for use with the number of conductors installed.
3. Power distribution blocks shall be provided for splices or where quantity or size of conductors exceeds the terminal rating of the device to be connected. Power distribution blocks shall be equal to Square D by Schneider Electric Class 9080 Type LB or Mersen Electrical Power MPDB series. Provide with covers. Power distribution blocks shall be securely mounted in a code sized enclosure.
4. Field installed compression connectors for cable sizes 250 kcmil and larger shall have not less than two clamping elements or compression indents per wire.
5. Insulate splices and joints with materials approved for the particular use, location, voltage, and temperature. Insulation rating shall be not less than that of the conductor that is being joined.
6. Plastic electrical insulating tape: Flame retardant, cold and weather resistant.

### 2.3 CONTROL WIRING:

- A. Unless otherwise specified in other sections of these specifications, size control wiring as specified for power and lighting wiring, except the minimum size shall be not less than No. 14, 90 degrees C. insulation. Where stranded conductors are used, provide with spade type insulated copper terminals.
- B. Size wire large enough so that the voltage drop under inrush conditions does not adversely affect operation of the controls.

### 2.4 COMMUNICATION AND SIGNAL WIRING:

- A. Shall conform to the recommendations of the manufacturers of the communication and signal systems; however, not less than what is shown.
- B. Wiring shown is for typical systems. Provide wiring as recommended by the manufacturer for the systems being furnished.
- C. Multi-conductor cables shall have the conductors color coded.

### 2.5 WIRE LUBRICATING COMPOUND:

- A. The cable pulling lubricant shall be compatible with all cable jackets. The lubricant shall be UL (or CSA) listed. The lubricant shall contain no waxes, greases, silicones, or polyalkylene glycol oils or waxes.
- B. A 200-gram sample of the lubricant, when placed in an one-foot, split metal conduit and fully dried for 24 hours at 105 degrees C, shall not spread a flame more than three-inches beyond a point of ignition at a continued heat flux of 40 kW/m<sup>2</sup>. Total time of test shall be one-half hour.
- C. Approved Lubricant is:
  1. Polywater J from American Polywater Corporation

PART 3 - EXECUTION

3.1 INSTALLATION, GENERALLY:

- A. Install in accordance with the NEC, and as specified.
- B. Install all wiring in raceway systems.
- C. Where No. 10 or No. 12 stranded conductors terminate at receptacles, toggle switches, or other devices with a screw-type connection, provide a solid conductor pigtail or spade-type connector listed for use with the appropriate class of stranded wire.
- D. Install a ground wire sized per NEC 250.122 in each conduit containing phase conductors.
- E. Color Code:
  - 1. All conductors shall be identified by circuit number and color coding at all termination points and splices. All conductors shall be identified in all pull and junction boxes by the following method of color coding. Means of identification shall be permanently posted at each branch circuit panel with a nameplate identifying color coding system used in that panelboard.

Phase	208Y/120V
A	Black
B	Red
C	Blue
Neutral	White
Ground	Green
Iso. Grd	Green w/Yellow

- 2. Use solid color compound or solid color coating for No. 6 and smaller branch circuit conductors and neutral sizes.
- 3. Phase conductors No. 4 and larger color code using one of the following:
  - a. Solid color compound or solid color coating.
  - b. Colored as specified using 3/4-inch wide tape. Apply tape in half overlapping turns for a minimum of three-inches for terminal points, and in junction boxes, pull boxes, troughs, manholes, and handholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable stating size and insulation type.
- 4. Where neutrals are located in the same raceway, junction box or enclosure, neutrals shall be marked or labeled to indicate which circuit conductor (phase conductor) they are associated with. Neutrals (with stripes matching the associated phase conductor color) meeting the requirements of NEC Section 200.6 are acceptable for this purpose.
- 5. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.
- 6. Provide plastic engraved color code legend on each panelboard and switchboard per NEC Section 210.5 (C).

7. All improperly color coded conductors will be completely replaced at no additional cost to Owner.
- F. All cable and wiring shall be continuous between electrical equipment. Splices shall not be added except as required for taps in branch circuits or as approved by the engineer.
- G. Splice cables and wires only in outlet boxes, junction boxes, pull boxes, manholes, or handholes. Do not splice cables in panelboards, switchboards, disconnects, etc.
- H. Install cable supports for all vertical feeders in accordance with the NEC. Provide split wedge type which firmly clamps each individual cable and tightens due to cable weight.
- I. For panelboards, cabinets, wireways, switches, and equipment assemblies, neatly form, and tie all cables.
- J. Seal cable and wire entering a building from underground between the wire and conduit, where the cable exits the conduit, with a non-hardening approved compound.
- K. Wire Pulling:
  1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables.
  2. Use ropes made of nonmetallic material for pulling feeders.
  3. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached directly to the conductors, as approved by the Engineer.
  4. Pull multiple cables into a single conduit with a single continuous pull.
  5. Use wire lubricant per this specification when recommended by the cable manufacturer or as required to prevent damage to cables during installation.

### 3.2 INSTALLATION IN MANHOLES:

- A. Install and support cables in manholes on the steel racks with porcelain or equal insulators. Train the cables around the manhole walls, but do not bend to a radius less than six times the overall cable diameter.

### 3.3 SPLICE INSTALLATION:

- A. Splices and terminations shall be mechanically and electrically secure.
- B. Where the Engineer determines that unsatisfactory splices or terminations have been installed, remove the devices and install approved devices at no additional cost to the Owner.

### 3.4 CONTROL, COMMUNICATION, AND SIGNAL WIRING INSTALLATION:

- A. Unless otherwise specified in other sections of these specifications, install wiring as described below. Wiring shall be connected to perform the functions shown and specified in other sections of this specification.
- B. Except where otherwise required, install a separate power supply circuit for each system, or control equipment, or control power. Circuit to nearest 120 volt panel or nearest



emergency panel if equipment controlled is connected to emergency system. Use spare 20 Amp breakers in panels where none are designated. Verify all requirements with actual equipment supplied in field.

- C. Install a breaker lock-on clip on the handle of the branch circuit breaker for the power supply circuit for each system to prevent accidental de-energizing of the systems. Lock-on clips for circuit breakers serving fire alarm systems shall be painted red.
- D. System voltages shall not exceed 120 volts and shall be lower voltages where shown on the drawings or required by the NEC.
- E. Wire and cable identification:
  - 1. Install a permanent wire marker on each wire at each termination, outlet box, junction box, panel, and device. Markers shall be typed or handwritten and shall be clearly legible.
  - 2. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
  - 3. Wire markers shall retain their markings after cleaning.
  - 4. In each manhole and handhole, install permanent, waterproof tags to identify the cable type/system and the building or area served.

### 3.5 FEEDER IDENTIFICATION:

- A. In each, interior pullbox and junction box, identify each phase, neutral and/or ground conductor by conductor color coding or tape based on system voltage.
- B. In manholes and handholes, install permanent, waterproof tags to identify the cable type. Identify each phase, neutral, and/or ground conductor by conductor color coding or tape based on system voltage.

### 3.6 FIELD TESTING:

- A. Feeders and branch circuits shall have their insulation tested after installation and before connection to utilization devices such as fixtures, motors, or appliances.
- B. Test shall be performed by megger and conductors shall test free from short-circuits and grounds.
- C. Test conductors' phase-to-phase and phase-to-ground.
- D. Megger motors after installation but before start-up and test free from grounds.
- E. The Contractor shall furnish the instruments, materials, and labor for these tests.

### 3.7 METAL CLAD (MC) CABLE:

- A. Metal Clad Cable may be utilized for branch circuit wiring from junction boxes to fixtures and wiring devices. All home runs shall be in conduit.

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- B. The use and installation of Metal Clad Cable shall conform to NEC Article 330, state and local codes and this specification. In all cases, the most restrictive requirements shall govern.
- C. Color coding of insulation shall comply with this specification.
- D. Support – Metal Clad Cable shall be supported at intervals not exceeding 6 feet and within 12 inches of every box, cabinet, fitting or other cable termination. Comply with additional requirements of Article 330, Section 330.30
- E. Install in a neat and workmanlike manner. Align and run cable parallel or perpendicular to the building lines.

END OF SECTION 260519

## SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.

#### 1.2 SUMMARY:

- A. This section includes grounding and bonding systems and equipment.
- B. This section includes grounding and bonding systems and equipment, plus the following special applications:
  - 1. Underground distribution grounding.

#### 1.3 SUBMITTALS:

- A. Product Data (Where indicated in Section "Common Work Results for Electrical", provide the following information): For each type of product indicated.
- B. As-Built Data: Plans showing dimensioned as-built locations of grounding features, including the following:
  - 1. Ground rods.
- C. Test Records: Submit the following test records to the Engineer for review and approval, and include in the operational and maintenance manuals:
  - 1. Grounding system tests per paragraph FIELD QUALITY CONTROL in Part 3 of this Section.

#### 1.4 QUALITY ASSURANCE:

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

### PART 2 - PRODUCTS

#### 2.1 CONDUCTORS:

- A. Insulated General Purpose: UL and NFPA 70 approved types, copper, with THW, XHHW or dual rated THHN-THWN insulation color identified green.
- B. Bare Copper Conductors:
  - 1. Solid Conductors: ASTM B3.

2. Stranded Conductors: ASTM B8.
  - C. Size conductors not less than what is shown on the drawings and not less than required by the NFPA 70.
- 2.2 GROUND BUS:
- A. Pre-drilled rectangular bars of annealed copper, 1/4 by 4 inches in cross-section with 9/32 inch holes spaced 1-1/8 inches apart. Stand-off insulators shall comply with UL 891 for use in switchboards, 600V and shall be Lexan or PVC, impulse tested at 5000V.
- 2.3 GROUND RODS:
- A. Copper-clad steel, sectional type, 3/4-inch diameter by 20 feet long.
- 2.4 CONNECTORS:
- A. Listed and labeled by a NRTL acceptable to the authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
  - B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.
  - C. Welded Connections:
    1. Exothermic welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
    2. For structural steel, steel grounding stud for compression connector.
  - D. Compression Connectors: Hydraulic crimped, irreversible compression type kits. Connectors shall be factory filled with oxide inhibitor. All crimps shall be made with a hydraulic tool that embosses the index number on the outside of the connector.
  - E. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long barrel, two-bolt connection to ground bus bar.
  - F. All splices and grounding electrode connections shall be made with exothermic welds or with hydraulic compression fittings.

### PART 3 - EXECUTION

- 3.1 APPLICATIONS:
- A. Conductors: Install solid or stranded conductors for #10 AWG and smaller and stranded conductors for #8 AWG and larger unless otherwise indicated.
  - B. Conductor Terminations and Connections:
    1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
    2. Underground Connections: Welded connectors or hydraulic compression connectors except as otherwise indicated.
    3. Connections to Structural Steel: Welded connectors.

4. Aboveground Connections to Ground Rods: Bolted connectors.

### 3.2 INSTALLATION, GENERALLY:

- A. Ground in accordance with the NFPA 70 as shown, and as hereinafter specified. All equipment ground conductors shall be terminated on a ground bus or ground lug attached to equipment can.
- B. Equipment Grounding:
  1. Metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be grounded for personnel safety and to provide a low impedance path for possible ground fault currents.
- C. Generator Grounding:
  1. Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

### 3.3 PRIMARY EQUIPMENT AND CIRCUITS:

- A. Comply with IEEE C2 (National Electrical Safety Code) grounding requirements.
- B. Duct Banks and Manholes:
  1. Provide a bare equipment grounding conductor in each duct bank containing medium or high voltage cables. Connect the grounding conductors to the switchgear ground bus, to all manhole hardware, to the cable shielding of medium or high voltage cable splices and terminations, and equipment enclosures.
  2. Provide a grounding conductor having at least 50 percent ampacity of the largest phase conductor in the duct bank.
  3. Provide a ground rod at each manhole. Seal floor opening with waterproof, nonshrink grout
  4. Connect the equipment grounding conductor to the ground rod.
- C. Lightning Arresters: Connect lightning arrester grounds to the equipment ground bus, or ground rods as applicable.
- D. Metallic Conduit: Metallic conduits which terminate without mechanical connection to housing of electrical equipment by means of locknut and bushings or adapters, provided with grounding bushings. Connect bushings with a bare grounding conductor to the equipment ground box.

### 3.4 SECONDARY EQUIPMENT AND CIRCUITS:

- A. Main Bonding Jumper: Connect the secondary service neutral to the ground bus in the service equipment.
- B. Water Pipe and Supplemental Electrode:

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1. Provide a ground conductor connection between the service equipment ground bus and the metallic water pipe system. Jumper insulating joints in the water pipe.
  2. Provide a supplemental grounding electrode and bond to the water pipe ground, or connect to the service equipment ground bar.
- C. Service Disconnect: Provide a ground bar bolted to the enclosure with lugs for connecting the various grounding conductors. Connect the neutral to the ground bus (main bonding jumper).
- D. Conduit Systems:
1. Ground all metallic conduit systems.
  2. Non-metallic conduit systems shall contain a grounding conductor.
  3. Conduit provided for mechanical protection containing only a grounding conductor, bond to that conductor at the entrance and exit from the conduit via grounding bushings.
- E. Feeders and Branch Circuits: Install green grounding conductors with feeders and branch circuits in all feeders and branch circuits and in any raceway containing a phase conductor.
- F. Boxes, Cabinets, Enclosures, and Panelboards:
1. Bond the grounding wires to each pullbox, junction box, outlet box, cabinets, and other enclosures through which the ground wires pass
  2. Make ground wire connections to ground bus in motor control centers, panelboards, etc.
- G. Receptacles and toggle switches are not approved for grounding through their mounting screws. Ground with a ground wire from green ground terminal on the device to the outlet box ground screw.
- H. Ground lighting fixtures to the green grounding conductor of the wiring system when the green ground is provided; otherwise, ground the fixtures through the conduit systems. Fixture connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.
- I. Fixed electrical appliances and equipment shall have a ground lug installed for termination of the green ground conductor.

3.5 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS:

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set top of rod 4 inches above finished floor. Seal floor opening with waterproof, non-shrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, puling irons, ladders, and cable shields within each manhole to ground rod or grounding conductor. Make connections with #4 AWG minimum, stranded, hard drawn copper bonding conductor. Train conductors level or plumb around corners and

fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and non-current carrying metal items to underground cable and grounding electrodes.

### 3.6 CONDUCTIVE PIPING:

- A. Bond all conductive piping systems in the building to the electrical system ground. Bonding connections shall be made as close as practical to the water pipe ground or service equipment ground bus.

### 3.7 SPLICES:

- A. All splices and grounding electrode connections shall be made with exothermic welds or with hydraulic compression fittings.

### 3.8 INSTALLATION:

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where subject to strain, impact, or damage.
- B. Grounding electrode conductors shall be continuous.

### 3.9 FIELD QUALITY CONTROL:

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation. Inspect compression type connections for proper die index number embossment.
- B. Perform the following testing:
  - 1. After installing grounding system, but before permanent electrical circuits have been energized, test for compliance with requirements.
  - 2. Test completed grounding system as each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at ground rods. Make tests at ground rods before any conductors are connected.
    - a. Measure ground resistance no fewer than two full days after the last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    - b. Perform tests by fall-of-potential method according to IEEE 81. Submit test results to the Engineer.

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- c. Excessive Ground Resistance: If resistance to ground exceeds specified values, promptly notify Engineer, and include recommendations for reducing ground resistance.

END OF SECTION 260526



## SECTION 260533 – RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Description:
  - 1. This section includes the furnishing, installation, and connection of raceways, fittings, and boxes to form complete, coordinated, grounded raceway systems. Raceways are required for all wiring unless shown or specified otherwise.
  - 2. The term conduit, as used in this specification, shall mean any or all of the raceway types specified.
- B. Section Includes:
  - 1. Metal conduits, tubing, and fittings.
  - 2. Non-metallic conduits and fittings.
  - 3. Metal wireways and auxiliary gutters.
  - 4. Surface raceways.
  - 5. Boxes and enclosures.
  - 6. Handholes and boxes for exterior underground cabling.

#### 1.3 DEFINITIONS:

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.
- D. RGS: Rigid galvanized steel.

#### 1.4 ACTION SUBMITTALS:

- A. Product Data (Where indicated in Section “Common Work Results for Electrical”, provide the following information): For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings (Where indicated in Section “Common Work Results for Electrical”, provide the following information): For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

## PART 2 - PRODUCTS

### 2.1 CONDUIT:

- A. Raceway Size: In accordance with the NFPA 70 but not less than 1/2-inch unless otherwise shown. Where permitted by the NFPA 70, 1/2-inch flexible conduit may be used for connections to recessed lighting fixtures.
- B. Raceway Supports:
  - 1. Parts and hardware: Zinc-coat or provide equivalent corrosion protection.
  - 2. Pipe Straps: Fed. Spec. FF-S-760, Type I, Style A or B.
  - 3. Individual Raceway Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
  - 4. Multiple Raceway (trapeze) hangers: Not less than 1-1/2 by 1-1/2 inch, 12 gauge steel, cold formed, lipped channels or not less than 2-1/8 by 2-1/8 inch, 18 gauge B-Line "4Dimension Channel"; with not less than 3/8-inch diameter steel hanger rods.
  - 5. Solid Masonry and Concrete Anchors: Fed. Spec. FF-S-325; Group III self-drilling expansion shields, or machine bolt expansion anchors Group II, Type 2 or 4, or Group VIII.

### 2.2 RACEWAYS:

- A. Install raceway types as shown on drawings and as listed below.
- B. Metal Conduit:
  - 1. Rigid steel: UL 6 and ANSI C80.1.
  - 2. Rigid aluminum: UL 6A and ANSI C80.5.
  - 3. Rigid intermediate steel conduit (IMC): UL 1242 and ANSI C80.6.
  - 4. Electrical metallic tubing (EMT): U.L. 797 and ANSI C80.3. Maximum size 5-inch. Permitted only with cable rated 600 volts or less.
  - 5. Flexible steel conduit (commercial Greenfield): UL 1, zinc-coated steel.
  - 6. Liquid-tight flexible metal conduit: UL 360 flexible galvanized steel tubing covered with extruded liquid-tight jacket of polyvinyl chloride (PVC). Provide conduit with a continuous copper bonding conductor spiral between the convolutions.
  - 7. PVC Coated Rigid Steel: NEMA RN 1. Conduit and fittings shall be as manufactured by Robroy Industries; Plasti-Bond, Perma-Cote, and KorKap or Thomas & Betts; Ocal. Any deviation will require approval of the specifying Engineer or Owner.
    - a. Shall be UL listed.
    - b. All male threads on conduit, elbows and nipples shall be protected by application of a urethane coating.
    - c. All female threads on fittings or conduit couplings shall be protected by application of a urethane coating.

C. Conduit Fittings for Metal Conduit:

1. Comply with NEMA FB 1 and UL 514B.
2. Rigid steel and IMC conduit fittings:
  - a. Standard threaded couplings, locknuts, bushings, and elbows: Fed. Spec. W-F-408, except only material of steel or malleable iron is acceptable. Integral retractable type IMC couplings are acceptable also.
  - b. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure
  - c. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted. Bushings for conduit smaller than 1-1/4-inch shall have flared bottom with ribbed sides.
  - d. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
  - e. Sealing fittings: Threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank coverplates having the same finishes as that of other electrical plates in the room.
  - f. In trade sizes 2-1/2 inches to 4-inches for rigid steel raceway or intermediate metal raceway, contractor may use Allied 'Kwik-Couple' fittings in lieu of individual steel couplings. 'Kwik-Couple' fittings shall not be used in hazardous locations. Where 'Kwik-Couple' fittings are used exterior for vertical risers, install fitting with taper end up.
3. Rigid aluminum conduit fittings:
  - a. Standard threaded couplings, locknuts, bushings, and elbows: Malleable iron, steel or aluminum alloy materials. Zinc or cadmium plate iron or steel fittings. Aluminum fittings containing more than 0.4 percent copper are prohibited.
  - b. Locknuts and bushings: As specified for rigid steel and IMC raceways.
  - c. Set screw fittings: Not permitted for use with aluminum raceway.
4. Electrical metallic tubing fittings:
  - a. Fed. Spec. W-F-408, except only material of steel for compression type. Steel or die-cast is acceptable for set screw type. Die-cast compression is not acceptable.
  - b. Couplings and connectors: Concrete tight and rain tight, with connectors having flared throats. Use gland and ring compression type or set screw type couplings and connectors. Set screw type couplings for conduit 2 inches and larger shall be four set screws each. Use set screws of case-hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.
  - c. Indenter type connectors or couplings are prohibited.

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- d. In trade sizes 1-1/4 inches to 4 inches, contractor may use Allied “Kwik-Fit EMT” or “Kwik-Fit Compression EMT” fittings in lieu of individual steel couplings.
- 5. Flexible steel conduit (greenfield) fittings:
    - a. Fed. Spec. W-F-406 and UL 5, except only steel or malleable iron material is acceptable.
    - b. Clamp type, with insulated throat.
  - 6. Liquid-tight flexible metal conduit fittings:
    - a. Fed. Spec. W-F-406, except only steel or malleable iron material is acceptable.
    - b. Type incorporating a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
  - 7. Expansion and deflection couplings:
    - a. UL 467 and UL 514.
    - b. Accommodate, 1.9 cm (0.75”) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
    - c. Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, NFPA 70 Section 250.98, and the NFPA 70 code tables for ground conductors.
    - d. Shall be watertight, seismically qualified, corrosion-resistant, threaded for and compatible with rigid or intermediate metal conduit.
    - e. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.
    - f. Expansion fittings shall accommodate a minimum of 4-inches of movement.
- D. Nonmetallic Conduit:
- 1. PVC Conduit: NEMA TC 2 and UL 651 Schedule 40, conduit size is 3/4-inch minimum.
- E. Conduit Fittings for Non-Metallic Conduits:
- 1. PVC Conduit: Comply with NEMA TC 3; match to conduit type and material.
- 2.3 OUTLET BOXES:
- A. UL-50, UL514A and NEMA OS 1.
  - B. Cast metal where required by NFPA 70 or shown, and equipped with rustproof boxes; NEMA FB 1.
  - C. Sheet metal boxes: 4-inch square, galvanized steel, except where otherwise shown.

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- D. Boxes installed in concrete or masonry and boxes larger than two gang shall be masonry type.
- E. Box extensions used to accommodate building finishes shall be of the same material as the recessed box.
- F. Boxes for use with IMC or RGS raceways shall be cast 'F' type or stainless steel unless noted otherwise on the drawings.
- G. Boxes for use with nonmetallic conduit: Comply with NEMA OS2 and UL 514C.

2.4 WIREWAYS AND AUXILIARY GUTTERS:

- A. Sized according to NFPA 70.
- B. Equip with hinged covers, except where removable covers are shown. Wireways shall only be permitted as indicated on the drawings or approved by the Engineer.
- C. Fittings and accessories: Include covers, couplings, offsets, elbows expansion joints, adapters, hold down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.
- D. Metal Wireways:
  - 1. Sheet metal complying with UL 870 and NEMA 250.
  - 2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70 and shall be marked for intended location and application.

2.5 PULL AND JUNCTION BOXES:

- A. Small boxes shall comply with NEMA OS 1.
- B. Larger boxes shall comply with UL 50 and NEMA 250.
- C. Pull and junction boxes shall be code gauge steel boxes with hinged, bolted or screwed covers. Boxes shall be flush or surface mounted as shown or required.
- D. Junction and pull box shall be installed where shown on drawings and additional boxes shall be installed if required for pulling of wire provided location and installation is approved by the Engineer. All boxes shall be code construction with screw type cover and shall be installed in accessible locations.
- E. Pull and junction boxes for use with IMC or RGS raceways shall be cast 'FS' type or stainless steel unless noted otherwise on the drawings. Comply with NEMA FB 1 and UL 1773 with gasketed cover.

2.6 FLOOR BOXES:

- A. Floor boxes shall be as specified on the drawings or in the Special Outlet Schedule. General installation / construction shall be as follows:
  - 1. Shall be listed and labeled as defined in NFPA 70.

2. Floor box housings for single and multi-gang floor boxes shall be fully adjustable, concrete tight with knockouts on bottom and all four sides (1/2", 3/4" and 1" sizes). Deep boxes shall be used when concrete floor thickness above any part of deck is 4-inch thick or more. Shallow boxes shall be used when concrete floor thickness is 3-inch up to 4-inch.
3. Cover plates shall be polished brass unless noted otherwise. Dual hinged lift lids for duplex receptacles, removable plug insert sized to match the receptacle to be installed for single special receptacles, telephone, TV, microphone, or other low voltage devices.
4. Provide low profile carpet flanges in all carpeted areas. Colors to be per Engineer.
5. Approved manufacturers shall be Hubbell or Steel City unless noted otherwise on the plans and/or in the special outlet schedule.

## 2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
- B. Comply with SCTE 77.
- C. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
- D. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
- E. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- F. Cover Legend: Molded lettering shall be "ELECTRIC" for power handholes and "COMMUNICATIONS" or "CONTROLS" as applicable for low voltage handholes.
- G. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
- H. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
- I. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete.

## PART 3 - EXECUTION

### 3.1 RACEWAY:

- A. Minimum 1/2-inch above grade, 3/4-inch below grade, and 1-inch on site, unless otherwise noted.
- B. A ground wire, sized per NFPA 70 Section 250.122 shall be installed in all conduits containing phase conductor(s).

- C. RGS or IMC must be used at all times when exposed to weather or physical abuse and in all NFPA 70 classified hazardous locations. EMT may not be used in direct contact with earth, or in concrete slabs on grade.
- D. U.L. approved Schedule 40 P.V.C. conduit may be used where feeders or branch circuits are to be run in earth or slabs (3/4" minimum).
  - 1. Use PVC coated RGS ells and risers approved for underground use. All conduit risers through concrete floors shall be RGS from below the top of the floor slab. Use conduit adapters when converting from PVC to steel conduit.
  - 2. Use plastic spacers when more than one conduit is installed together. See Drawings for areas requiring concrete encasement.
- E. All nonmetallic (PVC) conduits shall be provided with separate ground conductor sized per NFPA 70.

### 3.2 PENETRATIONS:

- A. Cutting or Holes:
  - 1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the Structural Engineer prior to drilling through structural sections.
  - 2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Structural Engineer as required by limited working space.
- B. Fire Stop:
  - 1. Where conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases, and maintains specified fire rating. Completely fill and seal clearances between raceways and openings with the fire stop material. See Section "Common Work Results for Low Voltage Systems Cabling" for firestopping requirements for low voltage cabling sleeves.
- C. Fire Barrier Penetration Seals:
  - 1. Manufacturer: Subject to compliance with requirements, provide fire barrier penetration seals of one of the following:
    - a. Electro Products Div./3M
    - b. Nelson; Unit of General Signal.
  - 2. Provide seals for any opening through fire-rated walls, floors, ceilings, or assemblies used as passage for components such as conduits or cables.
  - 3. Cracks, voids or holes up to 4-inch diameter: Use putty or caulking, one-piece intumescent elastomer, non-corrosive to metal, compatible with synthetic cable

jackets, and capable of expanding 10 times when exposed to flame or heat and UL-listed.

4. Openings greater than 4-inch diameter and raceway sleeves thru floors at telephone terminal boards: Use sealing system capable of passing 3-hour fire test in accordance with ASTM E-814, consisting of wall wrap or liner, partitions, and end caps capable of expanding when exposed to temperatures of 250 degrees to 350 degrees F (121 to 177·C), that is UL-listed. KBS "Sealbags" manufactured by P-W Industries will be acceptable.
5. Execution: Fill entire opening with sealing compound. Adhere to manufacturer's installation instructions. All fire barrier seals shall meet the rating of the wall.

D. Waterproofing:

1. Install sleeves and sleeve seals at exterior floor, exterior wall, and roof conduit penetrations and completely seal clearances around the conduit and sleeve and make watertight as specified in Section, SEALING AND CAULKING.

3.3 CONDUIT SYSTEMS INSTALLATION, GENERAL:

A. Installation: In accordance with UL, NFPA 70, as shown, and as hereinafter specified.

1. Where non-metallic (PVC) conduits are used, a ground wire sized per NFPA 70 Section 250.122 shall be provided if not already specified.

B. Raceway Burial Depths: (Underground work)

1. 18" minimum, 30" maximum cover to grade or bottom of floor slab.
2. 24" minimum under streets, highways, roads, alleys, driveways and parking lots.
3. 2" minimum below concrete slab inside a building.
4. Prior to any underground work, contractor shall verify and locate all existing underground utilities. All existing utilities may not be shown on the drawings. Verify in field with owner and with utility locating services. The contractor shall exercise extreme caution when trenching or boring, hand digging at all crossings and where in close proximity of existing utilities. Repair existing parking lots, streets, roads, alleys, driveways, etc. to its original condition in a timely manner prior to substantial completion. Contractor shall be responsible for any damage to underground utilities.
5. Underground conduits shall be installed in a sand bed and in an organized manner.

C. Install raceways as follows:

1. Comply with NECA 1, comply with NECA 101 for metal conduit and NECA 102 for aluminum conduit except where requirements on drawings or this article are stricter.
2. In complete runs before pulling in cables or wires.
3. Flattened, dented, or deformed raceways are not permitted. Remove and replace the damaged raceways with new undamaged material.
4. Assure raceway installation does not encroach into the ceiling height head room, walkways, or doorways.
5. Cut square with a hacksaw, ream, remove burrs, and draw up tight.
6. Mechanically and electrically continuous.



7. Independently support raceway. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, mechanical piping, or mechanical ducts.). Group raceways with common supports where possible. Conduit shall be supported within 12-inches of connectors.
8. Close ends of empty raceway with plugs or caps at the rough-in stage to prevent entry of debris, until wires are pulled in.
9. Raceway installations under fume and vent hoods are prohibited.
10. Secure raceways to cabinets, junction boxes, pull boxes and outlet boxes with bonding type locknuts. For RGS and IMC raceway installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make raceway connections to junction box covers.
11. Flashing of penetrations of the roof membrane is specified in Section, FLASHING AND SHEET METAL.
12. Raceways shall not be used as a support.
13. Use thread compounds that are UL approved conductive type to ensure low resistance ground continuity through the raceways.
14. Tightening set screws with pliers is prohibited.
15. Keep raceways a minimum of 6 inches away from parallel runs of flues and steam or hot-water pipes.

D. Raceway Bends:

1. Make bends with standard raceway bending machines.
2. Raceway hickey may be used for slight offsets, and for straightening stubbed out raceways.
3. Bending of raceways with a pipe tee or vise is prohibited.

E. Raceways Installed Under Metal - Corrugated Sheet Roof Decking

1. Where rigid metal conduit or intermediate metal conduit is not used, raceways shall be installed and supported so the nearest outside surface of the raceway is not less than 1.5 inches from the nearest surface of the roof decking.

F. PVC coated RGS:

1. Use only fittings listed for use with this type of conduit.
2. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduit and fittings. Use sealant recommended by conduit manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameter of the coated conduit.
4. All clamping, cutting, threading, bending, and assembly instructions listed in the manufacturer's installation guide should be vigorously followed. Installer certification, before installation, is required.

3.4 CONCEALED WORK INSTALLATION:

A. General:

1. Raceway and Outlet Boxes Installation: All raceway systems work and outlet boxes shall be installed concealed in walls, floor and roof construction or

concealed within furred spaces or above ceilings. In equipment or mechanical rooms exposed work shall include feeders and connections to equipment unless noted otherwise.

B. In Concrete:

1. Raceway: RGS, IMC, PVC or EMT; except do not install EMT in concrete slabs that are in contact with soil, gravel or vapor barriers.
2. Align and run raceways in direct lines.
3. Install raceways through concrete beams only when the following occurs:
  - a. Where shown on the structural drawings.
  - b. As approved by the Structural Engineer prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
4. Installation of raceways in concrete that is less than three inches thick is prohibited. All raceways installed in concrete shall be approved by the Structural Engineer.
  - a. Raceway outside diameter larger than one-third of the slab thickness is prohibited.
  - b. Space between raceways in slabs: Approximately six conduit diameters apart, except one conduit diameter at conduit crossings.
  - c. Install raceways approximately in the center of the slab so that there will be a minimum of 3/4-inch of concrete around the raceways.
5. Make couplings and connections watertight.

C. Above Furred or Suspended Ceilings and in Walls:

1. Raceways for conductors 600 volts and below:
  - a. RGS, IMC, rigid aluminum, or EMT. Types mixed indiscriminately in the same system are prohibited.
  - b. Do not use aluminum in wet locations or in contact with concrete.
2. Align and run raceways parallel or perpendicular to the building lines.
3. Connect recessed or lay-in lighting fixtures and all other devices installed in a lay-in ceiling to raceway runs with flexible metal conduit extending from a junction box to the fixture. Provide a ground wire in all flexible conduits.
4. Tightening set screws with pliers is prohibited.

3.5 EXPOSED WORK INSTALLATION:

A. Raceways for Conductors 600 volts and below:

1. RGS, IMC, rigid aluminum, or EMT. Types mixed indiscriminately in the system are prohibited.
2. Do not use aluminum in wet locations or in contact with concrete.
3. All raceways exposed to physical abuse and in all industrial pump, treatment plant locations shall be RGS, or IMC.

- B. Align and run raceways parallel or perpendicular to the building lines.
- C. Install horizontal runs close to the ceiling or beams and secure with raceway straps.
- D. Surface metallic raceways:
  - 1. Surface metallic raceway shall only be used where shown on the drawings, and in remodels and modifications to existing where wall and ceiling voids do not permit concealed installation but shall not be used at any other location unless called for on the drawings.
  - 2. All surface raceway and outlets must be painted to match the surface it is attached to.
  - 3. Install a ground wire sized per NFPA 70 Section 250.122 for the largest circuit in the raceway if not already specified.
- E. Painting:
  - 1. Paint exposed raceways as specified in Section, PAINTING.
  - 2. Paint raceways containing cables rated over 600 volts safety orange as specified in Section, PAINTING. In addition, paint legends, using 2-inch high black numerals and letters, showing the cable voltage rating. Provide legends where raceways pass through walls and floors and at maximum 20-foot intervals in between.

### 3.6 WET OR DAMP LOCATIONS:

- A. Unless otherwise shown, use raceways of RGS or IMC above grade. Use PVC conduit below grade, except RGS ells and risers shall be used.
- B. Provide sealing fittings, to prevent passage of water vapor, where raceways pass from warm to cold locations, i.e., (refrigerated spaces, constant temperature rooms, air conditioned spaces) or similar spaces.
- C. When RGS ells and risers are used below grade or when RGS or IMC conduit or RGS ells and risers are used below concrete building slabs in contact with soil, gravel, or vapor barriers, conduit shall have a minimum 20 mil PVC tape or coated with bituminous asphaltum compound.
- D. Rooftops:
  - 1. Where raceways or cables are exposed to direct sunlight on or above rooftops, raceways or cables shall be installed a minimum of 7/8" above the roof to the bottom of the raceway or cable.
  - 2. The ampacity of conductors or cables shall be de-rated in accordance with N.E.C. Section 310.15(B)(3)(c).
  - 3. Raceways or cables shall be supported up off the surface of the roof with a polymeric rooftop support equal to Caddy Pyramid series. Supports shall be non-penetrating and shall be designed to prevent damage to the roofing materials. Wood supports are not allowed.

3.7 CORROSIVE LOCATIONS:

- A. Conduit shall be PVC coated RGS.

3.8 MOTORS AND VIBRATING EQUIPMENT:

- A. Use flexible metal conduit (Type FMC) for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission. Provide liquid-tight flexible metal conduit Type (LFMC) for installation in exterior locations, kitchens, moisture or humidity laden atmosphere, water or spray wash-down operations, treatment plants, pump stations, and locations subject to seepage or dripping of oil, grease or water. Provide a green ground wire with all flexible metal conduit.

3.9 EXPANSION JOINTS:

- A. Expansion fittings shall be used wherever the change in length of PVC conduit due to temperature variation exceeds 0.25-inches per NEC Section 352.44.
- B. All conduits routed outdoors or in non-conditioned spaces (i.e., attics, non-insulated plenums, etc.) shall have expansion fittings per the following:
  - 1. Steel: One expansion fitting in runs longer than 40 feet. Provide additional expansion fittings every 200 feet.
  - 2. Aluminum: One expansion fitting in runs longer than 20 feet. Provide additional expansion fittings every 100 feet.
  - 3. PVC: One expansion fitting in runs longer than 20 feet. Provide additional expansion fittings every 50 feet.
- C. Equip raceways 3-inches and larger, that are rigidly secured to the building structure on opposite sides of a building expansion joint, with expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.
- D. Equip raceways smaller than 3-inches, that are rigidly secured to the building structure on opposite sides of a building expansion joint, with junction boxes located 12-inches either side of the expansion joint. Connect junction boxes with 24-inches of flexible conduit that is slack (to allow for movement). Flexible conduit shall have an insulated copper bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for 3-inches and larger conduits are acceptable.

3.10 RACEWAY SUPPORTS, INSTALLATION:

- A. All raceways shall have supports at maximum spacing of 10-feet and within 3-feet of a fitting, elbow, change of direction, box outlet or enclosure. Safe working load shall not exceed 1/4 of proof test load of fastening devices. This shall apply to both vertical and horizontal conduit runs.
- B. Use pipe straps or individual raceway hangers for supporting individual conduits.
- C. Support multiple raceway runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the raceways, wires,

hanger itself, and 200 pounds. Attach each raceway with U-bolts or other approved fasteners.

- D. Support raceways independently of junction boxes; pull boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.
- E. Fasteners and Supports in Solid Masonry and Concrete:
  - 1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
  - 2. Existing Construction:
    - a. Steel expansion anchors not less than 1/4-inch bolt size and not less than 1-1/8 inch embedment.
    - b. Power set fasteners not less than 1/4-inch diameter with depth of penetration not less than 3-inches.
    - c. Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
- F. Hollow Masonry: Toggle bolts are permitted. Bolts supported only by plaster are not acceptable.
- G. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- H. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
- I. Chair, wire, or perforated strap shall not be used to support or fasten conduit.
- J. Spring steel type supports "caddy clips" that are listed for the intended use are acceptable in appropriate locations.
- K. Vertical Supports: Vertical raceway runs shall have riser clamps and supports in accordance with NFPA 70 and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

### 3.11 BOX INSTALLATION:

- A. Boxes for Concealed Raceways:
  - 1. Mount flush. Boxes protruding from the finished wall surface or with more than 1/8-inch gap between the wall or outlet mounted in the box will be changed out with all wall reconstruction expense paid by the Electrical Contractor.
  - 2. Provide raised covers for boxes to suit the wall or ceiling, construction and finish.
- B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling in operations.
- C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.

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- D. Outlet boxes in the same wall mounted back-to-back are prohibited.
- E. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 4-inches square by 2-1/8 inches deep, with device covers for the wall material and thickness involved.
- F. Where lighting fixtures and appliance outlets are to be mounted in concrete or in plaster finish on concrete, outlet boxes shall be installed in forms at exact dimensions from bench marks, columns, walls or floors.
- G. Where lighting fixtures and appliances outlets are to be mounted on masonry walls and/or plastered furring or other finish, outlet boxes shall be roughed into general location before installation of wall and furring and shall be reset to exact dimensions before walls and furring are constructed.
- H. All outlet boxes shall be set true to horizontal and vertical lines parallel to walls, floors and ceilings and true to finish lines. All boxes shall be secured to ceilings or walls so all installations are solidly mounted.
- I. Boxes mounted to wall studs shall be secured to a horizontal box mounting bracket equal to B-Line Series #BB2 or Caddy Series #SGB. B-Line Series #BB4, Caddy Series #H23 or equal one piece support brackets may be used for mounting light switch boxes only. However, metal stud clips with far side box supports are not acceptable.
- J. Boxes for exterior exposed work (where approved by the engineer) shall be Appleton or Pyle National Type FS or FSC for shallow devices and Type FD or FDC for deep devices. Boxes for ceiling mounted light fixtures shall have approved no-bolt fixture studs. Boxes used as junction boxes shall have beveled edge flat steel blank cover.
- K. Where outlet boxes are mounted exposed in unfinished areas, (where approved by the engineer) surface mounted boxes shall be 4-inches square, have rounded corners and 1/2-inch raised steel cover plates.
- L. Location of outlets on small drawings is approximate and exact dimensions for locations of outlets shall be as taken from large scale plans and details on drawings or as directed by the Engineer.
  - 1. Outlets shall be located generally from column centers and finished wall lines or to center of wall or joints between wall panels. Ceiling outlets shall be installed at elevation of suspended ceiling connected to outlets in ceiling or slab above. Where necessary to fit and center with panel or ceilings and wall spaces, the contractor must, at no expense the Owner, shift the lighting outlets or other outlets as required by the Engineer.
- M. Boxes for switches and receptacles installed in columns shall be located off center to allow for future partitions.
- N. Boxes for switches at or near door shall be installed on the side opposite the hinge. Verify door swing direction prior to rough-in.

- O. To prevent sound from traveling through walls, electrical devices from different rooms shall not be mounted in the same stud place. Through-wall boxes shall not be used. In fire rated walls or partitions, outlet boxes on opposite sides of walls or partitions shall be separated by a horizontal distance of 24-inches. Outlet boxes larger than 4-inch square shall not be installed in fire rated walls or partitions. Verify location of fire rated walls or partitions with Architectural drawings prior to rough-in.
- P. Mark all junction boxes and pull boxes and/or the conduit where it enters the box with panel designation and circuit number in permanent, black marker. Mark on the outside where located in unfinished spaces and mark on the inside in finished spaces.

3.12 TELEPHONE, CABLE TV, COMMUNICATIONS, SECURITY AND OTHER SYSTEMS CONDUIT:

- A. These specifications include the furnishing of all labor and materials necessary for the complete installation of a system of conduits, outlets, and boards for use by the system suppliers.
- B. This installation must be done according to the requirements of the system suppliers and the general specifications covering "Light and Power" herewith.
- C. Provide and install pull boxes at all locations as required by the system suppliers. Mark all pull boxes and/or the conduit where it enters the box with type of system in permanent, black marker. Mark on the outside where located in unfinished spaces and mark on the inside in finished spaces.
- D. Provide and install conduit sleeves thru floors and walls as required by the system suppliers.
- E. The systems shall be provided with main service conduit sized as indicated on drawings. Each phone, data or TV location requires 1-inch empty conduit with pull rope unless noted otherwise. Conduits shall be routed to nearest associated telephone or data terminal board or above lay-in ceiling. If ceiling is an air return plenum, cables shall be routed completely in conduit or must be rated for use in air return plenum. Verify conditions of job prior to rough-in.
- F. Outlets:
  - 1. All wall outlets shall be installed with standard square box, plates furnished by system suppliers, or as directed. All outlets to be located as directed. Outlet boxes not used shall be provided with blank covers.
- G. Install the raceway system as shown on drawings.
- H. All conduit ends shall be equipped with non-metallic insulated bushings.
- I. All 2, 3 and 4-inch conduits within buildings shall include pull boxes after every two 90 degree bends. Size per NFPA 70 Article 370.
- J. Vertical conduits/sleeves through closets floors shall terminate not less than 3-inches above the floor and not less than 3-inches below the ceiling of the floor below.

- K. Terminate conduit runs to/from the associated telephone or data backboard in a closet or designated space at the top or bottom of the backboard. Conduits shall enter closets next to the wall and be flush with the backboard.
- L. Where drilling is necessary for vertical conduits, locate holes so as not to affect structural sections such as ribs or beams.
- M. All empty conduits located in equipment closets or on backboards shall be sealed with a standard non-hardening duct seal compound to prevent the entrance of moisture and gases and to meet fire resistance requirements.
- N. Conduit runs shall contain no more than four quarter turns (90 degree bends) between pull boxes/backboards.
- O. Furnish and install nylon pull rope in all empty conduits. (Sleeves through floor/wall are exceptions).

3.13 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES:

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from ½-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finish grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes with bottom below frost line.
- E. Where conduits enter side of enclosures, field-cut openings for conduits according to manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.14 COLOR CODING OF BOXES, ENCLOSURES, CONDUIT AND RACEWAYS:

- A. All boxes, enclosures, conduit and raceways, shall be color coded as follows:
  - 1. Essential Electrical System:
    - a. Equipment Branch: Green
    - b. Building Automation and Controls: Blue

END OF SECTION 260533



## SECTION 262726 - WIRING DEVICES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY:

- A. This section includes the furnishing, installation, and connection of wiring devices.
  - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
  - 2. Tamper-resistant receptacles.
  - 3. Weather-resistant receptacles.

#### 1.3 DEFINITIONS:

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.

#### 1.4 ADMINISTRATIVE REQUIREMENTS:

- A. Coordination:
  - 1. Receptacles for Owner Furnished Equipment: Match plug configurations.

#### 1.5 ACTION SUBMITTALS:

- A. Product Data (Where indicated in Section "Common Work Results for Electrical", provide the following information): For each type of product.
- B. Shop Drawings (Where indicated in Section "Common Work Results for Electrical", provide the following information): List of legends and description of materials and process used for premarking wall plates.

#### 1.6 CLOSEOUT SUBMITTALS:

- A. Operational and Maintenance Data: For wiring devices to include all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

**PART 2 - PRODUCTS**

**2.1 GENERAL WIRING DEVICE REQUIREMENTS:**

- A. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.
- B. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.

**2.2 RECEPTACLES:**

- A. Comply with NEMA WD 1, NEMA WD 6, and UL 498.
- B. LIST OF ACCEPTABLE RECEPTACLE MANUFACTURERS

Manufacturer	Volt	Hubbell / Kellems	Leviton	P&S	Bryant	Cooper Wiring Devices
<b>1. Specification Grade:</b>						
Duplex:	20 A. 125 V.	5352A	5352	5362	BRY5362	5352
Ground Fault:	20 A. 125 V.	GFRST20	G5362-WT	2097	---	---
Weather Resistant Ground Fault:	20 A. 125 V.	GFWRST20	G5362-WT	2097TRWR	---	---
Tamper/Weather Resistant GFCI:	20 A. 125 V.	GFTWRST20	G5362-WT	2097TRWR	---	---

- C. Weatherproof duplex receptacles shall be tamper resistant weather resistant GFCI grounded duplex receptacles.
  - 1. All receptacles shall be mounted with the same orientation (horizontal or vertical). When a different orientation is required or desired, obtain permission from the Engineer prior to rough-in.
  - 2. Damp Locations: Provide with a single weatherproof coverplate.
  - 3. Wet Locations: Provide "In-Use" extra-duty metallic weatherproof cover.
    - a. Hubbell #WP26E (vertical) or #WP26EH (horizontal)
    - b. Red Dot #CKMUV (vertical) or #CKMU (horizontal)
    - c. Taymac #MX3200(vertical) or #MX3300 (horizontal)
    - d. Intermatic #WP1010MXD (vertical) or #WP1010HMXD (horizontal)
- D. See plans for Special Outlet Schedule.
- E. Receptacle body shall be formed of high-impact nylon faced thermoplastic or urea and receptacle contacts shall be Bronze. Hard use industrial specification grade receptacles shall have a one piece brass bridge with integral ground contacts.
- F. When only one receptacle is connected to a 20 amp circuit by itself, that receptacle must be rated 20 Amp.
- G. All receptacles shall be self-grounding with ground lug.

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- H. Install receptacles to clear all cabinets, equipment, etc.
- I. Color of receptacles: Ivory. Verify colors prior to ordering.
- J. All 120V, 15 or 20A receptacles located, within kitchens, within 6 feet of a sink, exterior locations, elevator machine rooms, elevator pits, garages, per NFPA 70 and as located on the plans shall be ground fault circuit interrupters (GFCI) for personnel protection (Class A) with 5ma trip. Feed through GFCI receptacles or GFCI breakers may be used to protect other receptacles in the same room and on the same circuit if wired per the manufacturer's recommendations. Prior to final inspection, perform ground fault test on each protected receptacle and submit list of all receptacles tested with results to the Engineer. Label receptacles that are GFCI protected by another feed through GFCI receptacle or by GFCI breaker "GFCI protected".
- K. All 15 and 20 amp, 125 or 250 volt non-locking receptacles in damp or wet locations should be listed as "weather resistant".
- L. tolerated.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Installation shall be in accordance with NFPA 70, and as shown on the drawings.
- B. Comply with NECA 1.
- C. Switches shall be located on the latch side of all doors. If switches must be located on the hinge side of a door, they shall be located so that they are not behind the door when it is open. All questionable locations shall be brought to the Engineers attention.
- D. Verify all outlet locations on the job prior to rough-in. Locations may be altered up to 6'-0" in any direction without additional cost to the Owner.
- E. When conductors larger than #12 AWG are used on 15A or 20A circuits, splice #12 AWG pigtails for device connections.
- F. Install ground pin up on vertically mounted receptacles and install ground pin to the right on horizontally mounted receptacles.

3.2 FIELD QUALITY CONTROL:

- A. Convenience Receptacles:
  - 1. Verify ground continuity.
  - 2. Verify correct polarity of hot and neutral conductors.

END OF SECTION 262726

## SECTION 262810 - OVERCURRENT PROTECTIVE DEVICES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY:

- A. Section includes:
  - 1. Cartridge fuses rated 600 VAC and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers, and motor control centers.
  - 2. Plug fuses rated 125 VAC and less for use in enclosed switches and fuseholders.
  - 3.
  - 4. Molded Case Circuit Breakers (MCCBs)

#### 1.3 DEFINITIONS:

- A. MCCB: Molded Case Circuit Breaker

#### 1.4 SUBMITTALS:

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, and descriptions of individual components.
  - 1. Dimensions and manufacturer's technical data on features, performance, and electrical characteristics.
  - 2. Current and voltage ratings.
  - 3. Short-circuit current ratings (both interrupting and withstand, as appropriate).
  - 4. Evidence of UL listing for series rating of installed devices.
- B. Operation and Maintenance Data:
  - 1. Manufacturer's written instructions for testing, operating, and adjusting overcurrent protective devices.
  - 2. Summary of final settings for all adjustable overcurrent protective devices.

#### 1.5 QUALITY ASSURANCE:

- A. Source Limitations: Obtain overcurrent protective devices, components, and accessories, within same product category, through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for the intended locations and application.
- C. Comply with NFPA 70.

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- D. Comply with NEMA FU 1 for cartridge fuses.
- E. Comply with UL 248-11 for plug fuses.
- F. Comply with UL 489 for circuit breakers.

1.6 COORDINATION:

- A. Coordinate overcurrent protective device ratings with utilization equipment nameplate limitations of maximum fuse and/or breaker size and with system short-circuit current levels.
- B. Final fuse sizes for mechanical and other motor loads shall be selected by the fuse manufacturer to provide Type-2 “no damage” protection for equipment served. Contractor shall provide and install the selected fuses.

1.7 EXTRA MATERIALS:

- A. Furnish extra materials that match products installed and that are packaged in protective covering for storage and identified with labels describing contents.
  - 1. Fuses: Equal to 10 percent of quantity of installed fuses for each size and type but no fewer than three for each size and type.

PART 2 - PRODUCTS

2.1 FUSES:

- A. Manufacturers: Subject to compliance with requirements, provide product from one of the following list of manufacturers:
  - 1. Cooper Bussmann, Inc.
  - 2. Edison Fuse, Inc.
  - 3. Mersen Electrical Power
  - 4. Littelfuse, Inc.
- B. Cartridge Fuses:
  - 1. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
  - 2. Fuse Classes:
    - a. Class-CC: UL 248-4, time-delay, rejection type
    - b. Class-J: UL 248-8, dual-element, time-delay
    - c. Class-L: UL 248-10, dual-element, time-delay
- C. Plug Fuses:
  - 1. Characteristics: UL 248-11, dual-element, time-delay, Edison base.

2.2 MOLDED-CASE CIRCUIT BREAKERS:

- A. Shall be provided as factory installed components of panelboards or switchboards, or as separately enclosed units, as specified in other Sections or on the Drawings.
- B. Manufacturers: Subject to compliance with requirements, provide product from one of the following list of manufacturers:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
  - 2. General Electric Company
  - 3. Siemens Infrastructure and Cities (Siemens IC)
  - 4. Square D by Schneider Electric
- C. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- D. Standard Features and Accessories:
  - 1. Standard frame sizes, trip ratings, and number of poles.
  - 2. Line connections shall be bolt-on.
  - 3. Lugs: Mechanical type, suitable for the trip rating, number and size of conductors, and conductor material.
  - 4. Multi-pole units shall be enclosed in a single housing or be factory-assembled to operate as a single unit. They shall have a trip element for each pole, a common trip bar for all poles, and a single operator.
  - 5. Operating handle shall indicate ON, TRIPPED, and OFF positions.
  - 6. Shall be 80% rated, unless 100% rating is shown on the Drawings or is otherwise specified.
  - 7. Application Listing: Appropriate for application:
    - a. Type SWD for switching fluorescent lighting loads.
    - b. Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    - c. Type HACR for feeding heating, air conditioning, and refrigeration equipment.
- E. Optional Features and Accessories: Provide where indicated on the Drawings or otherwise specified.
  - 1. Ground-Fault Protection: Relay and trip unit with push-to-test feature.
- F. Thermal-Magnetic (or Non-Adjustable Electronic Trip) Circuit Breakers:
  - 1. Shall have inverse time element for low-level overloads.
  - 2. Shall have instantaneous magnetic trip element for short circuits.
  - 3. Shall have front-mounted, field-adjustable magnetic trip setting for circuit-breaker frame sizes 250 amperes and larger. Factory setting shall be LO, unless otherwise noted.
- G. Current-Limiting Circuit Breakers: Frame sizes 400 amperes and smaller; shall have let-through ratings less than NEMA FU 1, RK-5.

- H. Ground-Fault Circuit Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (5-mA trip) with self-test circuitry.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION:

- A. Examine overcurrent protective devices before installation. Reject units that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install overcurrent protective devices of sizes and with characteristics appropriate for each piece of equipment.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 FUSE APPLICATIONS:

- A. Cartridge Fuses:
  - 1. Service Entrance: Class-J for up to 600 A; Class-L for over 600 A
  - 2. Feeders: Class-J for up to 600 A; Class-L for over 600 A
  - 3. Motor branch circuits: Class-J for up to 600 A; Class-L for over 600 A
  - 4. Single-phase motor and other branch circuits where appropriate fuse holders are specified in other Sections: Class-CC
- B. Plug Fuses:
  - 1. Motor and other branch circuits: Edison-base type.

#### 3.3 CIRCUIT BREAKER APPLICATIONS:

- A. Refer to applicable Drawings and Specification Sections for information on types of circuit breakers to be installed in particular applications. Applicable Sections may include, but not be limited to, "Enclosed Switches and Circuit Breakers".

#### 3.4 INSTALLATION:

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

#### 3.5 IDENTIFICATION:

- A. Install labels complying with requirements found on the Drawings and elsewhere in this Specification. Install labels at every fused switch and each fuse block, socket, or holder which indicate fuse replacement information

END OF SECTION 262810

## SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY:

- A. Section includes:
  - 1. Fusible Switches
  - 2. Nonfusible Switches
  - 3. Toggle Type Switches
  - 4. Fustats
  - 5. Enclosures

#### 1.3 DEFINITIONS:

- A. NC: Normally closed
- B. NO: Normally open

#### 1.4 SUBMITTALS:

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, factory setting, accessories, and finishes.
  - 1. Enclosure types and details for types other than NEMA 250, Type 1.
  - 2. Current and voltage ratings.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work. Include wiring diagrams for power, signal, and control wiring.
- C. Operation and Maintenance Data: Include operation and maintenance data for all enclosed switches and circuit breakers in the operation and maintenance manuals. Data shall include, but not be limited to:
  - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

#### 1.5 QUALITY ASSURANCE:

- A. Source Limitations: Obtain enclosed switches and circuit breakers, components, and accessories, within same product category, through one source from a single manufacturer.



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- B. Product Selection for Restricted Space: Drawings may indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for the intended locations and application.
- D. Comply with NFPA 70.

1.6 COORDINATION:

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and requires clearances for equipment access doors and panels.

1.7 PROJECT CONDITIONS:

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions:
  - 1. Notify Owner in writing, not fewer than two days in advance of proposed interruption of service.
  - 2. Do not proceed with interruption of electric service without Owner's written permission.
  - 3. Comply with NFPA 70E.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES:

- A. Manufacturers: Subject to compliance with requirements, provide product from one of the following list of manufacturers:
  - 1. Allen-Bradley; Rockwell Automation
  - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit
  - 3. Eaton Electrical Inc.; Pringle Business Unit
  - 4. Siemens Infrastructure and Cities (Siemens IC)
  - 5. Square D by Schneider Electric
- B. Type GD General Duty switches are not allowed, unless specifically noted otherwise.
- C. Type HD, Heavy Duty, Single Throw, 1200 A and smaller: UL 98 and NEMA KS 1.
  - 1. Shall be horsepower rated for the load served.
  - 2. Shall have clips or bolt pads to accommodate the specified fuses, with rejection features to reject fuses other than those specified.
    - a. Refer to Section "Overcurrent Protective Devices" for specified fuse types.
  - 3. Shall have an external operating handle indicating ON and OFF positions, with provisions to padlock the switch in the OFF position.

4. Shall have a mechanical interlock to prevent the opening of the cover unless the handle is in the OFF position. This interlock shall be defeatable with a special tool to permit inspection.
  5. Shall have an equipment ground kit. Equipment ground shall be internally mounted and labeled for copper and aluminum ground conductors.
  6. Accessories: Provide where indicated on the Drawings or required to complete the intended design.
    - a. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
- D. Other specialty switch types, such as Six Pole or Double Throw, shall be provided where indicated on the Drawings or as necessary for the equipment served, and shall meet the requirements for Type HD single throw switches above.

## 2.2 NONFUSIBLE SWITCHES:

- A. Shall meet all requirements for FUSIBLE SWITCHES above, except that they shall not accept fuses.

## 2.3 TOGGLE TYPE SWITCHES:

- A. Shall be installed where indicated on the Drawings or elsewhere in the Specifications.
- B. Shall be 20 A, 30 A, 40 A, or 60 A, one, two, or three poles, voltage and horsepower rated for the load served.
- C. Shall be provided with matching steel coverplate, with provisions for padlocking the switch in the OFF position.
- D. Shall be provided with an appropriately sized mounting box where other than a standard outlet box is necessary for switch installation.

## 2.4 FUSTATS:

- A. 120 V motor loads up to 0.5 horsepower: Shall be horsepower rated and include an Edison-base fuse holder and integral toggle switch. Where located in damp or wet locations, provide weatherproof unit equal to Bussman #SSN.
- B. 120 V motor loads, 0.75 horsepower: Shall consist of a horsepower rated Edison-base fuse holder, with a separate horsepower rated toggle switch mounted adjacent to fuse holder.
- C. 120 V motor loads, 1 horsepower, or 277 V motor loads: Shall consist of a horsepower and voltage rated manual motor starter switch and a horsepower and voltage rated fuse holder designed to hold a time-delay Class CC rejection-type fuse.
  1. Manual motor starter switch: NEMA ICS 2, general purpose, Class A, with quick-make, quick-break toggle action, marked to indicate ON, OFF, and TRIPPED. Shall include an ambient-compensated type overload relay with inverse-time characteristics and NEMA ICS 2, Class 10 tripping characteristics. Shall have

heaters and sensors in each phase, matched to nameplate full-load current of specific motor it protects and appropriately adjusted for duty cycle.

2.5 ENCLOSURES:

- A. Comply with NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50.
- B. Enclosure Types: Shall be compatible with environmental conditions at installed locations, unless more stringent requirements are specified on the Drawings or elsewhere in the Specifications.
  - 1. Indoor Dry and Clean Locations: NEMA 250, Type 1.
  - 2. Outdoor Locations: NEMA 250, Type 3R.
  - 3. Hazardous Areas: NEMA 250, Type 7, 8, or 9, as indicated by hazard classification and environmental conditions at the installed location.
- C. Finished Spaces: In finished spaces, enclosures shall be flush mounted unless otherwise noted.

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated. Maximum mounting height and required working clearances shall comply with NFPA 70.
- B. Install fuses in fusible devices.
  - 1. Where fuses serve utilization equipment or motors, coordinate final fuse sizes with equipment nameplates and comply with listed minimum and maximum sizes.
  - 2. Plug fuses installed in fustats shall be sized for 125 percent of the nameplate full load amps or running load amps.
- C. Comply with NECA 1.

3.3 IDENTIFICATION:

- A. Identify field-installed conductors, interconnecting wiring, and components.
- B. Label each enclosure with engraved nameplate.

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3.4 ADJUSTING:

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262816

## SECTION 263213 - GENSETS AND ACCESSORY EQUIPMENT

### PART 1 - GENERAL

#### 1.1 SCOPE:

- A. This specification covers requirements for providing a complete and operable electric generating system, including all devices and equipment specified herein, shown on the drawings, and/or as required for the service. Materials and equipment shall be new, and delivered to the site completely wired, tested, and ready for installation. Each system shall include the following:
1. Engine-generator set as shown on the drawings and as herein specified.
  2. Engine-generator control console resiliently mounted on each generating set shall include complete engine start-stop control and solid-state monitoring system.
  3. Automatic transfer switch as specified in Section AUTOMATIC TRANSFER SWITCHES.
  4. Mounted and loose accessories, control devices, and other equipment as specified herein and/or as shown on drawings.
  5. Such other components, accessories, parts, tests, documents, and services, as needed to meet the performance requirements of this specification.
  6. Fuel tank, fuel, and rupture basin.
- B. The equipment and services specified herein shall be provided by a single supplier who has been regularly engaged in the sales and service of engines, generators, generator sets, . transfer switches, and controls for a minimum of ten years. The emergency electric generating system described herein, including those components along with the engine auxiliaries shall be factory built, factory tested, and shipped by this single supplier, so there is one source of supply and responsibility for warranty, parts, and service. Supplier shall maintain a service and maintenance facility within 50 miles of jobsite.
- C. The responsibility for performance to this specification in its entirety cannot be split up among individual suppliers of components comprising the system but must be assumed solely by the local authorized dealer of the generator set manufacturer. Specifically, note requirements for total system testing, equipment coordination and documentation.
- D. The system supplier shall provide literature and other information describing the equipment specified; data and other information shall be on the manufacturer's printed literature or letter head. Performance data shall be the result of test procedures in accordance with nationally recognized standards, in addition to such other procedures that are judged necessary by the manufacturer to ensure maximum service reliability for emergency systems and shall be available for inspection by the Engineer upon request.
- E. Approved Manufacturer: Generac

#### 1.2 SUBMITTALS:

- A. The following information must be submitted for approval.

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- B. Outline drawings of the equipment showing overall dimensions, power and control wiring entrance locations, breaker sizes and locations, lug sizes and locations, and front panel drawings showing all devices to be provided, with each device referenced to a material list with a complete description for the device.
- C. Interconnection detail drawing showing all control and power connections in the entire emergency system. Control connections between components are to be labeled with identical nomenclature.
- D. Literature describing in detail the equipment proposed, and all possible operating modes.
- E. A complete review of this specification, noting for each paragraph whether the proposed equipment complies with the project specifications, or deviates in some fashion. For each deviation, a justification for that deviation must be given.
- F. Complete test specification detailing the testing procedure to be used to verify the performance of the equipment provided.
- G. Submit generator sizing calculations based on the loads and steps indicated on the drawings and/or in this specification. Include the following:
  - 1. Steps/Loads detail report to include loads on each step and the generator load requirements for each step.
  - 2. Voltage dip and frequency dip per step.
  - 3. Recommended generator report indicating generator performance and load requirements.

1.3 INSTRUCTIONS, DRAWINGS, PARTS, AND OPERATION INFORMATION:

- A. Two copies of complete instructions shall be supplied to Owner prior to final acceptance.

1.4 MATERIAL SHALL BE IN BOOKLET FORM AND SHALL CONSIST OF OPERATING AND MAINTENANCE MANUALS, PARTS MANUALS, DIMENSIONAL DRAWINGS, WIRING DIAGRAMS AND SCHEMATICS, INTERCONNECTION WIRING DIAGRAMS, AND NECESSARY INFORMATION FOR PROPER OPERATION, SERVICE, AND MAINTENANCE OF THE EQUIPMENT AND MAJOR COMPONENTS SUPPLIED. WARRANTY:

- A. The complete standby electric power system, including engine-generator set, and automatic transfer switches shall be warranted for a period of five (5) years or fifteen hundred (1,500) operating hours, whichever occurs first, from the date of initial start-up.
- B. Warranty shall cover 100 percent of all parts and labor for the full warranty period. Multiple warranties for individual components (engine, alternator, controls, etc.) will not be acceptable.
- C. Satisfactory warranty documents must be provided with submittal documentation. In the judgment of the specifying authority, the manufacturer supplying the warranty for the complete system must have necessary financial strength and technical expertise with all components supplied to provide adequate warranty support.

1.5 CODES AND STANDARDS:

- A. The complete emergency power system, as installed, shall comply with all applicable local, state, and national standards.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS:

- A. Generac

2.2 LAYOUT AND DESIGN:

- A. The equipment spacing, mounts, electrical wiring, ventilation equipment, fuel, and exhaust components have all been sized and designed around a single manufacturer's equipment. The installing contractor shall be responsible for changes in the building work, made necessary from the installation of equipment other than specified, without additional cost to the Owner. (Verify all work with the equipment manufacturer.)

2.3 PERFORMANCE:

- A. The generator set shall provide 100 kW for an unlimited period of time under specified altitude and ambient conditions for all standby applications.
- B. The output of the generator set with specified governor and voltage regulator shall meet the following requirements:
  - 1. Random frequency variation will not exceed +/-0.5 percent (+/-0.3Hz) of its mean value for constant loads, no load to full load.
  - 2. Random voltage variation will not exceed +/-0.5 percent of it's for constant loads, from no load to full load.
  - 3. Frequency regulation under varying loads from no load to full load shall be isochronous.
  - 4. Voltage regulation under varying loads from no load to full load shall not exceed +/-1.0 percent.
  - 5. On application of maximum demand kW and KVA step as described below or on drawings, unit shall recover to stable operation and rated conditions within 10 seconds. Maximum voltage dip under these conditions shall not exceed 15 percent.
  - 6. Manufacturers of Generators shall submit calculations with marked data indicating generators will start the following items and still maintain voltage as identified above. Manufacturers shall increase kW rating of their unit if required by loads. Sizing shall be at the system voltage.
    - a. 7 KVA Misc. Power.
    - b. 23 Largest Motor (h.p.).
    - c. 23 Remaining Motors (h.p.)
    - d. In the event approved manufacturers require larger kW generator sizes than specified to meet loading requirements as listed above or on the drawings, the Electrical Contractor shall include in the bid amount required to increase feeder, transfer switch, main switchboard switch, distribution panel sizes, etc., as required for the increased kW size of the

generator to be provided. These changes shall be made with no increased cost to the Owner after the bid date. The Electrical Contractor shall submit with the generator shop drawings new feeder, switch, and panel sizes for approval by the engineer. The generator shop drawings shall be submitted prior to shop drawing submittal of the service and distribution equipment and any changes required to the equipment because of increased generator sizes shall be reflected on the equipment shop drawings prior to submittal to the Engineer.

#### 2.4 ENGINE-GENERATOR SET DESIGN:

- A. General: Each generator-set shall be mounted on suitable welded steel base to maintain proper alignment between components.
- B. Engine:
  - 1. Engine shall be stationary, liquid-cooled, diesel for use with Ultra Low Sulfur Diesel. Design shall be two or four cycle. Engine shall be certified by manufacturer as capable of driving a generator of kW rating as specified herein, for an unlimited time, in a standby application.
  - 2. Engine shall be capable of driving the generator of this rating for ambient conditions of 110 degrees F, 29.92 inches Hg (101 Kpa) barometric pressure, and 1500 ft. elevation.
  - 3. Arranged for direct connection to the alternating current generator.
- C. Engine equipment shall include:
  - 1. Remote two-wire, negative ground, 12/24 V.D.C. starting system. Provide electric starter, with two independent systems to disconnect the starting circuit upon engine starting.
  - 2. Positive displacement, mechanical, full pressure lubrication oil pump with pressure regulation valve, full flow oil filters with replaceable elements, integral oil cooler, dipstick oil level indicator, oil drain valve with hose extension.
  - 3. Primary and secondary fuel filters with replaceable elements, automatic shutoff all mounted on the engine. Replaceable dry element air cleaner.
  - 4. Provide all electronic, isochronous governor for isochronous frequency regulation. Frequency shall be regulated within .5% of any constant load condition from 0 to 100% of rated load.
  - 5. Necessary protective devices and engine gauges shall have sensing elements located on the engine to interface with the generator set control as specified under "Engine-Generator Control" herein.
  - 6. 35 Amp battery charging alternator with transistorized voltage regulator.
  - 7. Engine mounted, tank-type, engine coolant heaters, single-phase, 240 VAC, sized to ensure generator meets starting and load acceptance requirements of this specification, shall be provided for each engine. Contractor shall provide proper branch circuit(s).
  - 8. Engine protective devices shall include over cranking protection, low oil pressure, high coolant temperature, and overspeed shutdown.



2.5 ENGINE COOLING SYSTEMS:

- A. Engine shall be radiator cooled by a skid mounted radiator system. Genset cooling system shall be designed to allow operation of the genset at rated load under specified altitude and ambient conditions.
- B. Provide 50% ethylene glycol antifreeze solution to fill entire cooling system.
- C. The system shall include, unit mounted radiator, blower fan, water pump, thermostat and radiator duct fan.

2.6 ENGINE EXHAUST SYSTEM:

- A. Exhaust silencer shall be provided for each engine of size as recommended by manufacturer. Silencer shall be chambered construction. Contractor shall mount silencer, so its weight is not supported by the engine. Silencer shall be mounted as close as is practical to the engine.
- B. Flexible seamless stainless-steel exhaust connection shall be provided as required for connection between engine exhaust manifold and exhaust line (24" minimum).
- C. Provide an exhaust condensation trap with manual drain valve to trap and drain off exhaust condensation and to prevent condensation from entering the engine.
- D. Provide all necessary flanges and special fittings, etc. for proper installation.
- E. Contractor shall mount and install all exhaust components as shown on drawings and as required for code compliance. All components shall be properly sized to assure proper operation without excessive back pressure when installed as shown on drawings.
- F. Make provisions as required for pipe expansion and contraction.
- G. Contractor shall cover exhaust silencer and all indoor exhaust piping with a proper insulating material in a manner not to interfere with flexible exhaust connections.
- H. Thickness and type of insulation shall be shown on mechanical drawings.

2.7 ENGINE FUEL SYSTEMS:

- A. The manufacturer of the genset shall provide and warrant the complete engine fuel system, including fuel tank, rupture basin, fuel tank controls and leakage detection alarm. Provide all required items including, flexible fuel connector, fuel filter, leak detection alarm and cable.
- B. Contractor shall provide proper electric circuits for pumps that are energized from load side of generator building service breaker; day tank float switches shall cycle pumps to control fuel level in day tanks. Contractor shall provide necessary items to assure proper priming of all fuel pumps.
  - 1. Engine fuel storage shall consist of a U.L. Listed sub-base tank and have a minimum operational capacity of 24 hours of useable fuel.

2. Sub-base tank shall include the following control functions: low fuel level, rupture basin alarm. (Both functions shall signal at the remote annunciator.) Sub-base shall include visual sight gauge.
  3. Vibration isolator must be installed between sub-base tank and generator set when generator set does not incorporate vibration isolators as part of the factory mounting. Solid mounting will not be allowed.
  4. Fuel line from sub-base tank to engine generator shall be flexible and installed by engine generator supplier. Fuel line shall be suitable for diesel fuel.
  5. Sub-base tank shall be minimum construction of 7-gauge steel support channels, and 12 gauge tank construction. Electrical stub-up area shall be incorporated within the sub-base tank. Extend tank vent to exterior per NFPA. Provide flexible connection.
- C. Fill all fuel tanks with winterized fuel of the type required by the generator manufacturer. Label tank to indicate the type of fuel to be used, the nominal capacity of the tank and include "FUEL MUST BE WINTERIZED".

2.8 GENERATOR:

- A. Generator shall be single-bearing, drip-proof construction, synchronous type, revolving field, with direct drive centrifugal blower for cooling and minimum noise. Stator shall be skewed design and twice impregnated with high-temperature polyester varnish. Insulation shall be Class F or Class H per NEMA MG1.65 and BS 2757. Generator shall be directly connected to engine flywheel housing. Rotor shall be driven through a flexible coupling to insure permanent alignment. The maximum temperature rise at rated load shall not exceed 80 degrees C at 40 degrees C ambient (for Class F insulation) or 105 degrees C (for Class H insulation).
- B. Voltage regulator:
1. Regulator shall be three phase sensing, solid-state temperature compensated design and shall function by controlling the exciter magnetic field between stator and rotor. The voltage regulation system shall be insensitive to severe, load induced waveshape distortion from SCR or thyristor circuits such as those used in battery charging (UPS) and motor speed control equipment loads. Voltage regulator shall be mounted in the genset control panel.
  2. Voltage regulation system shall include overvoltage protection to protect the system against voltage regulator failure or loss of reference, and to protect the system loads from damaging overvoltage conditions.
  3. Voltage regulation system shall include permanent magnet exciter (PMG), to provide 250% of rated current for 10 seconds without damage to generator. After 10 seconds the generator field shall collapse to protect genset to switchgear power connections.
- C. The alternator, exciter, and voltage regulator shall be designed and manufactured by the generator set manufacturer so that the characteristics shall be matched to the torque curve of the prime mover. System shall provide automatic voltage reduction if the load demand exceeds the engine capacity to prevent engine stalling and saturation of magnetic components.

2.9 ENGINE-GENERATOR CONTROL:

- A. Provide a unit mounted control console that is factory built, wired, tested, and shock-mounted by the engine and generator manufacturer. Control console shall be mounted on the generator end of the set. Control wire shall have termination identification on each wire for ease of tracing. Control wires which run between generator set controls, and automatic load transfer controls shall have termination identification on both ends. Nameplates shall be provided to identify each device or function and shall be silk-screened white on a black background. The genset shall be capable of independent operation, without any control from remote equipment. Control panel shall meet NFPA 110.
- B. Engine-generator control shall include the following DC engine controls for each unit: Run-stop-remote switch; remote start-stop terminals; lighted oil pressure gauge; lighted coolant temperature gauge; lighted battery charge rate ammeter; running time meter, AC voltmeter (dual range), AC ammeter (dual range) volt/Amp phase selector switch with off position, frequency meter 45-66 HZ, voltage adjusting rheostat ( $\pm 5\%$  range). Digital meters may be used.
- C. All wiring for connection to remote devices shall be wired to properly numbered and labeled terminal blocks. Contractor shall install stranded wires to all remote devices.
- D. Provide cycle cranking system as recommended by engine manufacturer and cranking limiter with 75 second cranking cycle with lockout.
- E. Provide solid-state voltage regulator as described previously.
- F. Generator set monitoring system shall include solid-state engine monitor with individual lights with lamp test switch and one common external alarm contact to indicate each of the following conditions for each unit:
  1. Green Light:
    - a. Engine Run/Supplying Load
  2. Yellow Light:
    - a. High Coolant (Engine) Temperature (Pre-Alarm)
    - b. Low Oil Pressure (Pre-Alarm)
    - c. Low Fuel (Pre-Alarm)/Low Gas Pressure
    - d. Low Battery Voltage
    - e. High Battery Voltage
    - f. Low Coolant Level
    - g. Control Switch not in Automatic Position
    - h. Low Cranking Voltage
  3. Red Light:
    - a. Overcrank Shutdown
    - b. Overspeed Shutdown
    - c. High Coolant (Engine) Temperature Shutdown
    - d. Low Oil Pressure Shutdown

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- e. Low Coolant Temperature
  - f. Low Fuel
  - g. Battery Charger AC Failure
4. Flashing Red Light:
- a. Switch Off
  - b. Open/Tripped Circuit Breaker
- G. Provide one set of "form C" N.O./N.C. contacts to signal operation whenever the genset is running, 1 set for genset ready, 1 set for genset running, 1 set for genset fail, 1 set for genset low fuel and 1 set for generator breaker status. See control panel schedule.
- H. Provide lubricating oil temperature gauge.
- I. Provide low coolant level alarm and shutdown, which shall activate high engine temperature shutdown lamp and alarm.
- J. Provide wiring for normally open auxiliary dry contacts from each circuit breaker located between the generator and automatic transfer switch (including generator mounted circuit breakers).

2.10 AUXILIARY EQUIPMENT AND ACCESSORIES:

- A. Starting Batteries: A heavy-duty, diesel starting, lead-acid battery set shall be provided for each engine and shall be mounted on a battery rack furnished with the generator set. Provide all intercell and connecting battery cables.
- B. Battery Chargers:
- 1. Provide an SCR voltage regulated battery charger for each genset in the system. Battery charger shall be rated 10 amps minimum.
  - 2. Battery charger shall include the following features:
    - a. DC Voltmeter and Ammeter, 2% accuracy
    - b. On/Off Switch
    - c. 12 Hour Equalize Timer Control Switch
    - d. Alarm Indication Lamps and Dry Contacts to indicate the following conditions: Loss of AC Power, Low Battery Voltage, High Battery Voltage, and Power On.
    - e. Fuse protection of both the power transformer and bridge rectifier.
  - 3. Charger design shall allow charging current to taper to zero amperage when batteries are fully charged.
- C. Provide spring vibration isolators. Number and size as required by total system. Springs shall be near mid-point in field after complete installation.
- D. Each generator shall have a concrete isolation pad with raised portion under skids per the detail on the drawings. Exact size, depth, and steel arrangements shall be verified with the structural engineer after the generator shop drawings are approved.

- E. Main Unit Circuit breaker(s) at the generator. Sized per the drawings. Provide with normally open auxiliary dry contacts to indicate open or tripped condition. Connect to generator monitoring system.
- F. Emergency Shutdown Switch:
  - 1. Exterior Generator Installation: Switch is to be installed adjacent to the interior of the new metal entrance gate It shall be of the break-glass type, surface mounted, NEMA-3R rated. The operator shall be a maintained push-on/push-off button located behind the glass. Switch shall be provided with lettering to read "Emergency Generator Stop". Activation of switch shall alarm the remote annunciator and generator control panel. Switch shall be Pilla Electrical Products #ST120SN3RBP2SL or equal approved by Engineer.
- G. Provide all - weather lockable enclosure to protect the generator system. Install day tank between the skids within the enclosure. Exhaust silencer shall be mounted on top of the enclosure. Make all required modifications to the exhaust in the field.
- H. Enclosure and exhaust shall be sound attenuated and reduce the sound level of the engine generator while operating at full load to a maximum of 60dB(A) measured at any location 23 feet from the engine.
- I. Provide 48-hour sub-base tank with generator.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION:

- A. Emergency electric generating system, along with transfer switches, annunciators, generator sets, and all components shall be installed, including all connections, at locations and as indicated on drawings, and wiring diagrams as specified herein, and in accordance with approved shop drawings, manufacturer's instructions, and manufacturer's standard specification and dimension sheets.

#### 3.2 TESTING:

- A. The intent of this specification is to provide equipment of proven reliability and compatibility.
- B. Factory Production Model Tests:
  - 1. Before shipment of the equipment to the jobsite, the generator set, and other system components shall be tested together under rated load and power factor for proper functioning at the generator set manufacturer's facility, including control and interfacing circuits per the requirements of NFPA 110. No exceptions to the requirements of this paragraph will be accepted.
  - 2. Other Tests Shall Include:
    - a. Transient response and steady state governing, to demonstrate compliance with this specification.

3. The Engineer shall be notified in advance of these tests and shall be able to witness these tests. Certified copies of test results shall be forwarded to the Engineer for review, and approval before shipment of equipment to jobsite.

C. Field Tests After Installation:

1. The complete installation shall be initially started and checked out for operational compliance by factory trained representative(s) of the manufacturer of the generator sets, and automatic transfer switches. The engine lubrication oil and antifreeze, as recommended by the manufacturer for operation under environmental conditions specified, shall be provided by the supplier of the generator sets.
2. Upon completion of initial start-up and system checkout, the supplier of the generator sets shall perform a field test, with the Engineer notified in advance, to demonstrate load carrying capability, stability, voltage and frequency response.
3. Simulated power failure test - generator sets shall be made ready for automatic operation and started by means of the test transfer switch(es) on the automatic transfer switch(es). Units shall run for the duration of all time delays and then automatically shut down.
4. Startup to be as recommended by manufacturer.

D. Field Tests After Installation:

1. The complete installation shall be initially started and checked out for operational compliance by factory trained representative(s) of the manufacturer of the generator sets, paralleling equipment, and the automatic transfer switches. The engine lubrication oil and antifreeze, as recommended by the manufacturer for operation under environmental conditions specified, shall be provided by the supplier of the generator sets.
2. Upon completion of initial start-up and system checkout, the supplier of the generator sets shall perform a field test, with the Engineer notified in advance, to demonstrate load carrying capability, stability, voltage and frequency response.
3. Simulated power failure test - generator sets shall be made ready for automatic operation and started by means of the test transfer switch(es) on the automatic transfer switch(es). Units shall run for the duration of all time delays and then automatically shut down.
4. The system shall be operated for six hours continuously at the maximum rated load level; except that load shall not exceed 50 percent of generator set rating for first 1/2 hour, during first initial run for proper engine break-in. Records shall be maintained throughout this period to record water temperature, oil pressure, ambient air temperature, voltage, current, frequency and kilowatts. The above data shall be recorded at 15-minute intervals throughout the test. There shall be a 10-minute unloaded run at the conclusion of the test to allow engine to cool before shutdown. Three copies of the field test data shall be furnished to the Engineer. The contractor shall provide necessary cable and make all necessary hook-ups to accomplish field tests and shall furnish all fuel necessary for field test and refill all tanks after testing with winterized fuel.
5. The emergency system is to be tested at 100 percent of its nameplate kW rating at the jobsite.

3.3 LABELING AND PAINTING:

- A. Label the disconnect switch feeding the emergency system. "Emergency Power Disconnect Emergency Generator is Connected to this Feeder".

3.4 CAUTION SIGN:

- A. Electrical contractor shall provide and install an 8" x 11" white enamel finish on 20 gage steel panel (minimum size) secured to the housing of the generator with 3/4" high stenciled red letters: "CAUTION". This Plant Starts Automatically. It May Start At Any Time. "Letters shall be neat and legible. Panel shall be visible to anyone approaching the generator plant.
- B. Install nameplate on 'ATS' and labeled as follows: "This building is provided with a standby emergency generator located adjacent to main service transformer. "Nameplate shall be the same size and type as required for switchboards except that front and back shall be red with white core.

3.5 OWNER ORIENTATION:

- A. A representative of the supplier shall meet with a representative of the Owner at the time of final acceptance tests and shall review the operation and parts books, correct starting and control methods, and recommend preventive maintenance procedures.

END OF SECTION 263213

## SECTION 263600 - TRANSFER SWITCHES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the contract, including general and supplemental conditions, apply to this section.

#### 1.2 DESCRIPTION:

- A. This section includes the furnishing, installation, and connection of automatic transfer switches.

#### 1.3 SUBMITTALS:

- A. Product Data: For each type of automatic transfer switch include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material list for each switch specified.
- C. Operation and Maintenance Data: Include operation and maintenance data for all automatic transfer switches and components in the operation and maintenance manuals. Data shall include but not be limited to:
  - 1. Features and operating sequences.
  - 2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

#### 1.4 QUALITY ASSURANCE:

- A. Source Limitation: Obtain automatic transfer switches, components, and accessories from a single manufacturer.

### PART 2 - PRODUCTS

#### 2.1 GENERAL REQUIREMENTS FOR AUTOMATIC TRANSFER SWITCHES:

- A. Automatic transfer switches shall be in accordance with UL, NEMA, NEC, ANSI, NFPA, as specified and as shown on the drawings.
- B. Automatic transfer switches are to be electrically operated, mechanically held, open contact type, without integral overcurrent protection. Transfer switches utilizing automatic or non-automatic molded case circuit breakers as switching mechanisms are not acceptable.
- C. Automatic transfer switches shall be UL listed under UL 1008 and, where applicable, also meet the additional withstand test requirements as specified.



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- D. The unit shall be completely assembled and factory wired so that only external circuit connections are required in the field. The unit shall include, but not be limited to, operating mechanism, main contact, auxiliary contacts, timers, pilot lights, switches, and auxiliary sensing devices.

2.2 APPROVED MANUFACTURERS:

- A. Generac

2.3 RATINGS, MARKINGS AND TESTS:

A. Ratings:

1. Phase, voltage, and ampere rating shall be as shown on the drawings. Switches shall be break before making switched neutral 4 pole for 3 phase 4 wire systems. The ampere rating shall be for 100 percent continuous load current.
2. Transfer switches are to be rated for total system transfer on emergency systems.
3. Ratings shall be with non-welding of contacts during the performance of the withstand and closing tests.
4. Automatic transfer switch shall be service entrance rated.

B. Markings:

1. Markings shall be in accordance with UL 1008.
2. Markings for the additional withstand test hereinafter specified are waived when the testing laboratory is other than UL.

C. Tests:

1. Transfer switches shall be tested in accordance with UL 1008. The contacts of the transfer switch shall not weld during the performance of the withstand and closing tests.

2.4 HOUSING:

- A. Enclose transfer switches in steel cabinets in accordance with UL 508, or in a switchboard assembly in accordance with UL 891, as shown on the drawings. Enclosures shall be NEMA 1 for interior applications and NEMA 3R with cabinet heater and thermostat for exterior applications.
- B. Doors: Shall have three-point latching mechanism where required.
- C. Padlocking Provisions: Provide chain for attaching a padlock. Attach chain to the cabinet by welding or riveting.
- D. Finish: Cabinets shall be given a phosphate treatment, painted with rust inhibiting primer, and finish painted with the manufacturer's standard enamel or lacquer finish.

2.5 FEATURES: TRANSFER SWITCHES SHALL INCLUDE THE FOLLOWING:

- A. Operating Mechanism:
  - 1. Activated by an electrical operator.
  - 2. Electrically and mechanically interlocked so that the main contact cannot be closed simultaneously in both normal and emergency position.
  - 3. Normal and emergency main contacts shall be mechanically locked in position by the operating linkage upon completion of transfer. Release of the locking mechanism shall be possible only by normal operating action.
  - 4. Contact transfer time shall not exceed six cycles.
  - 5. Do not use as a current carrying part. Components and mechanical interlocks shall be insulated or grounded.
  
- B. Contacts:
  - 1. On switch sizes 400 amperes and larger, protect main contacts by separate arcing contacts and magnetic blowouts for each pole. Arc quenching provisions equivalent to magnetic blowouts will be considered for approval.
  - 2. Current carrying capacity of arcing contacts shall not be used in the determination of the transfer switch rating and shall be separate from the main contacts.
  - 3. Main and arcing contacts shall be visible for inspection with cabinet door open and barrier covers removed.
  
- C. Manual Operator:
  - 1. Capable of operation in either direction under no load.
  - 2. Capable of operation by one person.
  - 3. Provide a warning sign to caution against operation when energized.
  
- D. Replaceable Parts:
  - 1. Include the main and arcing contact individually or as units, relays, and control devices.
  - 2. Switch contacts and accessories are to be replaceable from the front without removing the switch from the cabinet and without removing main conductors.
  
- E. Sensing Relays:
  - 1. Provide voltage sensing relays in each phase of the normal power supply.
  - 2. Provide a voltage frequency sensing relay in one phase of the auxiliary power supply.

2.6 ACCESSORIES: TRANSFER SWITCHES SHALL INCLUDE THE FOLLOWING:

- A. Indicating Lights:
  - 1. Provide a signal light for normal source position.
  - 2. Provide a signal light for emergency source position.
  - 3. Lights shall be different colors.

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4. Provide laminated phenolic plastic, white front and back with black core, nameplates to indicate transfer switch position.
- B. Manual Test Switch: Shall simulate normal source failure.
- C. Engine starting contacts.
- D. Time Delay Relays:
  1. Provide time-delay relays to accomplish the function as specified below and on drawings.
- E. Auxiliary Contacts:
  1. Provide contacts for connection to controls, one closed when transfer switch is connected to normal, and one closed when transfer switch is connected to emergency.
  2. Provide additional contacts as necessary to accomplish the functions shown on the drawings, specified, and designated in other sections of these specifications.
  3. Contacts shall have a minimum rating of ten amperes and be positive acting on pickup and dropout.
- F. In phase monitor or center neutral position with time delay in neutral when switch controls motor larger than 10 HP.
- G. Automatic Exerciser:
  1. Clock exerciser for use with load.
  2. Exerciser for use without load.
- H. Automatic Transfer Switch Digital AC Meter package: Provide an AC Voltmeter, an Ammeter, a Frequency meter, and a Peak Demand Load Meter. Provide a phase selector switch to allow reading voltage and current line to line or three phase. Meters shall read either normal or emergency source. Meter package shall be provided on each automatic transfer switch.
- I. Heater: For exterior applications, provide electric heater with thermostat to maintain minimum temperature at any point within enclosure at 40 degrees F. Heater shall be sized based on ASHRAE 99.5% minimum temperatures for the project location. Heater shall be 240V. rated and operated at 120V. Manufacturer shall derate heater as required based on 120V. operating voltage.

2.7 TRANSFER SWITCH OPERATION:

- A. A voltage decrease in one or more phases of the normal power source to less than 70 percent of normal shall initiate the transfer sequence. The transfer switch shall start the engine-generator unit after a time-delay of two or three seconds to permit override of momentary dips in the normal power source. The time-delay shall be field adjustable from 0.5 to 6 seconds and factory set at 1 second.

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- B. The transfer switch shall transfer the load from normal to emergency source when the frequency and voltage of the engine-generator unit have attained 90 percent of rated value.
- C. Unload running time delay for emergency generator cool down. The time delay shall be field adjustable from 0 to 5 minutes and factory set at 5 minutes.
- D. Retransfer to Normal (All Loads): Transfer switch shall retransfer to normal source upon restoration of normal supply in all phases to 90 percent or more of normal voltage, and after a time-delay. Time-delays shall be field adjustable from five to twenty-five minutes (preset for twenty-five minutes). Should the emergency source fail during the timing, the transfer switch shall immediately transfer to normal when the source is available.
- E. Transfer to Emergency (Emergency System Loads): Transfer switches for emergency system loads shall transfer their loads from normal to emergency source when frequency and voltage of the engine-generator unit have attained 90 percent of rated value. Only those switches with deficient normal source voltage shall transfer.
- F. Transfer to Emergency (Equipment System or Optional Stand-By System Loads): Transfer switches for equipment system loads shall transfer their loads to the generator on a time-delayed staggered basis, after the emergency system switches have transferred. Total delayed transfer time of an equipment system switches shall not exceed two minutes. Time-delay relays shall be field adjustable from zero to two minutes.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Installation shall be in accordance with the NEC and as shown on the drawings.

3.2 SPARE PARTS: FURNISH THE FOLLOWING:

- A. Six spare control fuses of each rating.
- B. Six spare pilot lamps of each type used.

3.3 TESTING:

- A. When the complete system has been installed, and prior to the final inspection, test all components of the system in the presence of the engineer for proper operation of the individual components and the complete system and to eliminate electrical and mechanical defects.
- B. When any defects are detected, correct the defects and repeat the test as requested by the engineer, at no additional cost to the Owner.

3.4 INSTRUCTIONS AND FINAL INSPECTIONS:

- A. At the final inspection in the presence of the engineer, demonstrate that the complete auxiliary electrical power system operates properly in every respect.

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- B. Furnish the services of a competent, factory-trained engineer or technician for one four hour period, for instructing personnel in adjustment, operation, and maintenance of the equipment, on a date requested by the engineer.

END OF SECTION 263600

SECTION 264313 – SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY:

- A. Section includes field-mounted and factory-mounted surge protective devices for low-voltage (120 to 600 V) power distribution and control equipment.
- B. Related Sections:
  - 1. Division 26 Section “Wiring Devices” for devices with integral TVSS.

1.3 DEFINITIONS:

- A. ATS: Acceptance Testing Specifications.
- B. SPD: Surge Protective Device.
- C. TVSS: Transient voltage surge suppressor(s), both singular and plural; also, transient voltage surge suppression.
- D. VPR: Voltage Protection Rating.

1.4 SUBMITTALS:

- A. Product Data: For each type of product indicated. Include rated capacities; installed dimensions and operating weights; electrical characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Include wiring diagrams for power, signal, and control wiring.
- C. Operation and Maintenance Data: Include operation and maintenance data for all surge protective devices in the operation and maintenance manuals.

1.5 QUALITY ASSURANCE:

- A. Source Limitations: Obtain surge protective devices, components, and accessories, within same product category, through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for the intended locations and application.

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- C. The unit shall be UL 1449 Listed (internally mounted units shall be UL recognized) as a Surge Protective Device and UL 1283 Listed as an Electromagnetic Interference Filter. Internally mounted units shall maintain the UL Listing of the equipment they are mounted in.
- D. Comply with NFPA 70.
- E. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.

1.6 COORDINATION:

- A. Coordinate layout and installation of surge protective devices and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate surge protective devices with Division 26 Section "Electrical Power Monitoring and Control."

1.7 PROJECT CONDITIONS:

- A. Service Conditions: Rate surge protective devices for continuous operation under the following conditions unless otherwise indicated:
  - 1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage for 480/277Y and not less than 125 percent of nominal system operating voltage for 208/120Y.
  - 2. Operating Temperature: 30 to 150 deg F (0 to 65 deg C).
  - 3. Humidity: 0 to 95 percent, non-condensing.
  - 4. Altitude: Less than 12,000 feet above sea level.

1.8 EXTRA MATERIALS:

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Replaceable Protection Modules: 1 of each size and type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide product from one of the following list of manufacturers:
  - 1. Current Technologies
  - 2. Cutler Hammer
  - 3. General Electric Company
  - 4. Liebert Corp.
  - 5. Siemens Infrastructure and Cities (Siemens IC)
  - 6. Square D by Schneider Electric
  - 7. Transvector

2.2 GENERAL REQUIREMENTS:

- A. UL 1449 Listed.
- B. Internally mounted within the electrical equipment unless noted otherwise.
- C. Modular design with field-replaceable modules, minimum of 1 module per phase.
- D. MOV's shall be individually fused per mode, with a 200-kA minimum interrupting capacity and shall be classified by the NEC as an overcurrent protection device allowing tapped device conductors from a disconnect without an overcurrent device.
- E. UL 1449 minimum nominal discharge current rating of 20kA per mode.
- F. Bolted compression lugs for internal wiring.
- G. Integral disconnecting means if direct bussed connected.
- H. Redundant suppression circuits.
- I. LED indicator lights for power and protection status.
- J. On board diagnostic monitoring with audible alarm, and silencing switch, to indicate when protection has failed and when failure of even one MOV has occurred.
- K. Surge-event operations counter.
- L. EMI/RFI filtering of -50dB @ 100kHz.
- M. Protection Modes and UL 1449 Maximum Voltage Protection Ratings shall be as follows:

Voltage	Line-to-Neutral	Line-to-Ground	Neutral-to-Ground	Line-to-Line
120/208Y, 3 Phase, 4 Wire	700V	800V	700V	1200V

2.3 PANELBOARD SURGE PROTECTIVE DEVICES:

- A. Devices shall be factory installed with direct bussed connections where possible.
- B. If the manufacturer requires a disconnect, an integral disconnect switch or molded case breaker (60 amp min.) shall be provided. Submit testing to demonstrate that overcurrent devices do not open upon peak single impulse surge current test.
- C. Arrangement with bussed or wire connections to phase buses, neutral bus, and ground bus. Ground and neutral buses should be relocated to minimize connection lengths. If cables are used, they shall be the lowest impedance possible. Wires shall be kept as short and straight as possible. Do not exceed manufacturer's recommended lead lengths.



- D. Modifications to the panelboard shall be UL labeled as a panelboard and as a SPD. For two and three section panelboards, the SPD module shall be installed in the first section where the line connections occur.
- E. Peak Single-Impulse Surge Current Rating: 150 kA per phase.

2.4 ENCLOSURES:

- A. Internally mounted unless otherwise specified. Add-on devices shall comply with NEMA 250, matching the enclosure or panel being protected.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTIVE DEVICES:

- A. Install devices at service entrance on load side of main disconnect, with ground lead bonded to service entrance ground.
- B. SPD equipment and devices. Upon completion the Representative shall submit a letter certifying the complete installation is per this specification and per all manufacturer's requirements and recommendations.
- C. Retrofit and Add-On Surge Protective Devices:
  - 1. Disconnect switch or molded case circuit breaker shall be located in the first section of the panelboard to be protected.
  - 2. Cables shall have the lowest impedance possible. Locate the switch nearest to the main breaker or M.L.O. Locate the suppressor beside the switch with a close nipple connection. Connect to switch with high strand count #2 Cu. welding cables 6" preferred, (18" maximum length).
  - 3. Do not exceed manufacturer's recommended lead lengths.

3.2 CONNECTIONS:

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL:

- A. Testing: Perform the following field quality-control testing:
  - 1. After installing surge protective devices, but before electrical circuitry has been energized, test for compliance with manufacturer's published field testing requirements.
  - 2. Complete startup checks according to manufacturer's written instructions.
  - 3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.19. Certify compliance with test parameters.
- B. Manufacturer shall repair or replace malfunctioning units. Retest after repairs or replacements are made.

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- C. Verify that electrical wiring installation complies with this specification and manufacturer's installation requirements.
- D. Do not perform insulation resistance (megger) tests of the distribution wiring equipment with the surge protective devices installed. Disconnect all wires, including neutral, before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.4 START-UP SERVICE:

- A. The manufacturer shall train the Owner's maintenance personnel to adjust, operate, and maintain surge protective devices (minimum one (1) hr of field training).
  - 1. Train Owner's maintenance personnel on procedures and schedules for maintaining suppressors.
  - 2. Review data in maintenance manuals.
  - 3. Contractor shall schedule training with Owner, through Engineer, with at least seven days advance notice.

END OF SECTION 264313