100% PROJECT MANUAL

COMMERCE 2.0 MGD GROVE CREEK WPCP

COMMERCE, GEORGIA

for

CITY OF COMMERCE

BID DOCUMENTS

March 2025

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GMC PROJECT NUMBER: CATL230033

STATE OF GEORGIA
GOODWYN MILLS CAWOOD, LLC
No.PEF007898
Exp.06.30.2026
CERTIFICATE OF AUTHORIZATION

GEORGIA
REGISTERED
No. PE051452
PROFESSIONAL
Graham Sizemore
03.19.2025
ENGINEER
GRAHAM S. SIZEMORE

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COMMERCE 2.0 MGD GROVE CREEK
WATER POLLUTION CONTROL PLANT

FOR

CITY OF COMMERCE

COMMERCE, GEORGIA

GMC PROJECT NO. CATL230033

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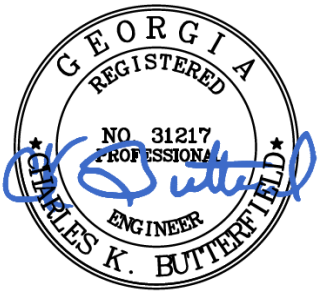

SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 GENERAL

A. Work covered by this Specification to include furnishing of labor, materials, and equipment required for installation, testing and putting into proper operation complete Electrical systems as shown on the Drawings and as hereinafter specified. The Contractor shall include cutting, trenching and backfilling, etc., necessary for the complete installation.

1. Work shall include power distribution, controls, lighting systems, instrumentation and metering, wiring and telephone service (where required).

B. Provide all materials, equipment, labor and services to complete the installation, wiring, testing and commissioning of the complete and functioning electrical systems, including but not limited to the scope of work specified in this section.

C. Notify the Engineer of any conflicts between Codes, Specification and Drawings, plan and riser. The maximum condition is to govern, and the selection shall be based on whichever indicates the greater cost.

1.2 SCOPE

A. The Contractor's scope of work encompasses a comprehensive list of tasks, including but not limited to supplying, delivering, unloading, assembling, initiating, testing, commissioning, and ultimately transferring the electrical services installation described in detail in the specifications and indicated on the Drawings, all in adherence to the contract documents.

B. The Contractor shall of thoroughly review and comprehend the specification and the extent of the work. Additionally, they are tasked with providing all the necessary conduit, wiring, power supplies, accessories, and supplementary components required to ensure the safe and proper operation of the power, control and instrumentation systems.

C. The Contractor is responsible for the following:

1. To visit the site and become familiar with the scope of work.

2. To prepare shop drawings and obtain approvals from relevant authorities before commencing work.

3. To secure approvals for materials and workmanship during the execution and upon completion of the project.

4. To incorporate all costs and charges associated with local authorities (fees, permits and testing), as well as those related to permanent power supply connections. The Contractor will be responsible for covering any power connection charges.

5. Collaborate with other trades to ensure the coordinated placement of fixtures, outlets, equipment, and devices, thereby preventing any conflicts.

6. Furnish all anchor bolts, inserts, and supports as required to be installed by other trades as needed.

1.3 RELATED SECTIONS

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

B. Section 26 05 19 Conductors

C. Section 26 05 26 Grounding and Bonding

D. Section 26 05 33 Raceway and Boxes

E. Section 26 22 13 Low Voltage Transformers

F. Section 26 24 16 Panelboards

G. Section 26 27 26 Wiring Devices

H. Section 26 28 11 Molded Case Circuit Breakers

I. Section 26 28 16 Safety Switches

J. Section 26 29 23 Variable Frequency Drives

K. Section 26 50 00 Lighting

1.4 REFRENCES

A. The equipment in this specification is designed and manufactured according to latest revision of the following standards (unless otherwise noted).

1. NPFA 101 - Life Safety Code

2. American Society for Testing and Materials (ASTM)

3. Insulated Cable Engineers Association (ICEA)

4. Institute of Electrical and Electronics Engineers (IEEE)

5. International Society of Automation (ISA)

6. National Electrical Manufacturers Association (NEMA)

7. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)

8. National Standards Institute (ANSI)

9. Underwriters Laboratories (UL)

1.5 DEFINITIONS

A. Unless specifically defined within the Contract Documents, the words or acronyms contained within this specification shall be as defined within, or by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.

1.6 SUBMITTALS

A. Manufacturer shall provide copies of following documents to owner for review and evaluation in accordance with general requirements of Division 1 and Division 26:

B. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.

C. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.

D. Contractor's submittal shall include a list of manufacturers of principal items of equipment and material including conduit tubing and fittings, power conductors, wireway, outlet boxes and terminals, pull boxes and junction boxes, manholes and handholes, control cable, receptacles, surge suppressors, switches, etc. Full information shall be furnished on products of manufacturers not named in the Contract Documents.

E. Shop drawings shall be submitted giving performance data, physical size, wiring diagrams, materials, etc., for control centers, lighting fixtures, motor controllers, panelboards, conduit and duct, and cable and wire.

F. The requirements of each electrical system shall be identified by the Contractor before submission of shop drawings, and all necessary accessory parts required between items of electrical equipment shall be identified in sufficient detail to prove that the total equipment furnished and installed will operate as specified and shown on the Drawings.

G. Shop drawings and samples shall be thoroughly checked and coordinated by the Contractor for details and fulfillment of Contract requirements prior to submittal. Approval of any item does not relieve Contractor of responsibility for coordinating dimensions and work required by other trades.

1.7 PROJECT RECORD DRAWINGS

A. Maintain an up-to-date set of Contract documents. Note any and all revisions and deviations that are made during the course of the project.

B. Provide final typical outline drawing

1.8 OPERATION AND MAINTENANCE DATA

A. Manufacturer shall provide copies of installation, operation and maintenance procedures to owner in accordance with general requirements of Division 1 and Division 26.

B. Submit operation and maintenance data based on factory and field testing, operation and maintenance of specified products.

C. Include the following information in the Operation and Maintenance manuals:

1. Names and address of local suppliers for the items included.

2. Details of design elements, construction features, component function and maintenance requirements, to permit effective startup, operation, maintenance, repair, modification, extension and expansion of any portion or feature of the installation.

3. Technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items and parts lists. Advertising or sales literature is not acceptable.

4. Review information provided in the maintenance instructions and manuals with the Owners' operating personnel to ensure a complete understanding of the electrical equipment and systems and their operation.

1.9 QUALITY ASSURANCE

A. All work performed and all materials used shall be in accordance with the National Electrical Code, and with applicable local regulations and ordinances. Equipment, assemblies and materials shall be listed and labeled by Underwriter's Laboratories or by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products in accordance with the manufacturer recommendations.

B. All materials shall be unloaded and stored in a manner to avoid physical damage or detrimental effects of exposure to weather.

1.11 WARRANTY

A. Contractor shall warranty all work executed under this section will be free from defects of workmanship and materials for a period of one (1) year from date of final acceptance of this work.

B. The Contractor responsible for repairing and replacing, at their own expense any defective work, and all other work damaged thereby, which becomes defective during warranty period.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Submittals: The Contractor is responsible for organizing and structuring the material submittals, along with related drawings, for approval by the Engineer. These submittals should include the necessary details as requested by the Engineer.

B. Substitutions: The Contractor is required to select items and materials either from the approved list of suppliers/manufacturers or provide an alternative option for approval. However, this alternative choice is limited to a single selection, and if it's rejected, the Contractor must revert to using the approved suppliers/manufacturers list. Contractor shall not use substitutions without written approval from the Engineer.

1. Substitutions shall meet the following minimum requirements:

    a. Capacities indicated are the absolute minimum

    b. Compatibility with other materials and equipment

    c. Interchangeability

    d. Noise levels

    e. Physical size limitations

    f. Same manufacturer where practicable

    g. Structural requirements

C. Materials must meet the following criteria:

1. Be designed, manufactured, and tested in compliance with the latest versions of all relevant UL and other applicable industry standards.

2. Be certified by UL, ANSI, NEMA or be acceptable to the relevant authorities, including special inspection if required.

3. All electrical equipment must be designed to operate in a 122°F ambient temperature with 100% relative humidity.

4. If multiple items of the same type are required, they must all be of the same type and manufacturer.

5. Products from specified manufacturers are acceptable only when they comply with or are modified as necessary to meet the contract document requirements.

6. Items of equipment or materials not explicitly defined herein should conform to the general standard of quality established in this document.

2.2 FINISHES

A. Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

B. Clean and touch up surfaces of shop-painted equipment scratched during shipment or installation, to match original paint.

C. Clean and prime exposed non-galvanized hangers, racks and fasteners to prevent rusting.

PART 3 - EXECUTION

3.1 GENERAL

A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of Specification Division 26 and Drawings.

B. Inspect preceding work to ensure satisfactory completion prior to electrical work.

C. Coordinate work with local power company and Owner to minimize delays in operation of new facilities.

D. Wiring layouts or schematics are not intended to show exact location of raceways, outlets, etc. Contractor shall refer to building plans and details for dimensions and shall fit his work to conform to details of building construction. The right is reserved to shift any switch, receptacle, ceiling or other outlet a maximum of 10' from its location as shown on Drawings before it is permanently installed without incurring additional expense.

3.2 INSTALLATION

A. Contractor shall furnish all labor and furnish, install, connect, test and adjust all equipment and materials to form a complete operating installation, including wiring hangers, supports for equipment, cables, conduits, cable tray, cable trench, pull boxes anchors and inserts, identification plates, signs, and tags for equipment, conduits, wiring and wiring labels.

B. The contractor must provide the following:

1. Circuits originating from branch distribution panels.

2. Lighting and its control.

3. Motors, heaters and associated control equipment including sequenced operation of systems where applicable.

4. Coordinate numbers and label all field wiring between equipment of the various electrical equipment suppliers.

5. All wiring for testing and trials, for all required corrections, changes, additions, completions and adjustments until final acceptance of the work.

C. The electrical work shall be installed in such a manner and at such times as will require a minimum of cutting and patching of the building structure.

D. Any damage to work already in place as a result of electrical work shall be repaired and made good at no expense to the Owner.

3.3 WORKMANSHIP

A. Install conduits and pipes parallel and perpendicular to the building planes and concealed in chases, behind furring or above ceiling, except in unfinished areas. Install all exposed systems neatly and grouped together, to present a neat appearance.

B. Install all equipment and apparatus requiring maintenance, adjustment or replacement with sufficient clearance for servicing.

C. Include in the work all requirements of the manufacturer and as shown on the shop drawings.

D. Replace any work unsatisfactory to the Engineer/Owner without extra cost.

3.4 IDENTIFICATION

A. Have the manufacturers nameplate affixed to each item of all equipment showing the size, name of equipment, serial number and all information usually provided, including voltage, frequency, # of phases, horsepower, etc., and the name of the manufacturer and his address. Ensure that all stamped, etched and engraved lettering on plates is perfectly legible. Ensure that nameplates are not painted over.

B. Identify all major items of equipment including control panels, panelboards, switchboards, transformers, VFD’s, enclosed motor starters, enclosed circuit breakers, disconnect switches and automatic transfer switches with wording approved by Engineer.

C. Each panel shall have each circuit identified. Panels without branch circuit nameplates shall have typewritten directories mounted on the panel door.

3.5 TESTING AND ACCEPTANCE:

A. Prior to acceptance by the Owner, all control systems shall function as required, and all motors shall be connected to protective devices and control devices associated with a machine or a group of machines to produce the correct operating, timing and sequencing necessary for the proper functioning of the mechanical equipment.

B. The Contractor is responsible for ensuring that all systems are prepared for operation and for having an electrician on hand to operate them in accordance with the Engineer's

representative(s) supervision. The Electrician should also be available to assist in the removal of panel fronts and other necessary actions to facilitate inspections as needed.

3.6 FIELD QUALITY CONTROL

A. Carefully check each piece of apparatus for completeness of connections, accessories, wiring and controls and place in operation, test and adjust.

B. Correct defects; repeat tests until no defects are disclosed; leave equipment clean and ready for use.

C. The Contractor is responsible for the following:

1. Power distribution system testing including proper rotation, phasing, voltage, grounding and load balancing.

2. Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.

3. Insulation resistance testing.

a. Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.

b. Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.

4. Check resistance to ground before energizing.

5. Any tests and commissioning work identified in the individual sections of Division 26.

6. Providing instruments, meters, equipment and personnel required to conduct tests.

7. Submit test results for Engineer's review.

D. Contractor shall not energize the electrical equipment covered in this Division without permission from the Engineer.

3.7 AS-BUILT DRAWINGS:

A. Submit one blueline print of the Drawings marked to show as-built locations including all changes, revisions and substitutions to the electrical work.

3.8 TEMPORARY SERVICES

A. Temporary electrical service for electrical power used during construction shall be provided and paid for by the Contractor.

B. Do not use any of the permanent electrical systems during construction, unless specific written approval is obtained from the Engineer or unless allowed elsewhere in the contract documents.

END OF SECTION 26 05 00

SECTION 26 05 19 – CONDUCTORS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide labor, material, equipment, related services, and supervision required, including, but not limited to installation, connections and testing of all wire and cable components including splices, terminations, connectors and accessories as required for the complete performance of the work, as shown on the Drawings, as specified herein.

B. RELATED SECTIONS

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

2. Division 26 Section "Common Work Results for Electrical".

1.2 REFRENCES

A. The equipment in this specification is designed and manufactured according to latest revision of the following standards (unless otherwise noted).

1. American Society for Testing and Materials (ASTM)

a. ASTM B3 – Standard Specification for Soft or Annealed Copper Wire

b. ASTM B8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

c. ASTM B496 – Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors

2. Insulated Cable Engineers Association (ICEA)

3. Institute of Electrical and Electronics Engineers (IEEE)

4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)

5. NEMA WC 70/ICEA S95-658

6. Underwriters Laboratories (UL)

a. UL 83 – Standard for Safety Thermoplastic-Insulated Wires and Cables

b. UL 1518 – Reference Standard for Electrical Wires, Cables, and Flexible Cords

1.3 SUBMITTALS

A. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.

B. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.

C. Manufacturer shall provide copies of following documents to owner for review and evaluation in accordance with general requirements of Division 1 and Division 26.

1. Product data on specified product documenting the following

a. Wire and cable.

b. Wire and cable accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle wire and cable in accordance with the manufacturer recommendations.

B. All materials shall be unloaded and stored in its original packaging in a manner to avoid physical damage or detrimental effects of exposure to weather.

1.5 WARRANTY

A. Provide a guarantee against defective materials and workmanship in accordance with requirements of the Section 26 05 00 of these Specifications.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Alcan Products Corporation, American Insulated Wire Corp, Belden CDT Inc., Encore Wire Corporation, General Cable Technologies Corporation, Southwire Incorporated, or Republic Wire.

B. Conductor insulation and multiconductor cables shall comply with NEMA WC 70/ICEA S95-658. Refer to Part 3 of this section for allowable types specific to this project.

C. MC Cable (Metal-Clad):

1. Provide Type MC Cables that are minimum 90 degrees C rated, with components and fittings listed for grounding, compliant with NEC Articles 250 and 330.

2. Provide compatible steel fittings with integral red plastic insulated throat bushings, compliant with NEC 330.

D. Conductors shall have current carrying capacities as per N.E.C. and with 600 volt insulation rated at 90 degrees, #12 minimum except for controls wire. Conductors shall be copper.

E. General Application

1. Provide stranded copper wire for #8 and larger conductors and #10 or smaller circuit terminating at motors. Provide solid copper conductors for #10 or smaller circuits not terminating at motors.

2. Service entrance conductors:

   a. Type USE-2, XHHW-2 insulation for service entrance conductors routed from exterior source to exterior termination location.

   b. Type XHHW-2 insulation for services entrance conductors routed from exterior source to interior termination location.

3. Above grade wire for exterior work within conduit:

   a. THHN/THWN, or XHHW-2 insulation.

4. Below grade wires including within slab on grade within conduit:

   a. Provide XHHW-2 insulation for #8 and larger conductors and THHN/THWN or XHHW-2 insulation for #10 or smaller circuits.

5. Multi-conductor shielded variable frequency drive conductors:

   a. Soft annealed flexible stranded copper conductors.

   b. 1kV XLPO or XLPE insulation (to resist the potential reflected voltages experienced in 600VAC VFD applications).

   c. Metallic shielded providing 100% shield coverage.

   d. AmerCable, Belden VFD cable or equal.

6. Grounding conductors

   a. Bare grounding conductor sized as shown on the Drawings. Conductors #6 and smaller may be solid. Conductors #4 and larger shall be stranded.

   b. Equipment grounding conductor stranded copper with green type THHN/THWN insulation.

7. Control circuits and conductors

a. Conductors shall be #12 or #14, seven strand as shown on the Drawings.

8. Instrument cable

a. 2 # 18 AWG, twisted shielded pair, UL Instrument Cable, XLPE conductor insulation, PVC outer jacket unless noted otherwise.

9. Ethernet cable

a. Provide Cat6a shielded twisted pair #23 AWG suited for outdoor use routed through conduits.

10. Fiber optic cable

a. Coordinate with SCADA integrator.

2.2 CONNECTIONS AND SPLICES

A. Subject to being equivalent and subject to compliance with requirements, provide products by one of the following manufacturers; AFC Cable Systems, Inc., Arrow-Hart Div, Crouse-Hinds, Gardner Bender, Hubbell Power Systems, Inc., Ideal Industries, Inc., Ilsco; a branch of Bardes Corporation, NSi Industries LLC., O-Z/Gedney, 3M; Tyco Electronics, Square D, or Thomas and Betts.

B. Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

C. Make joints and terminations with splice and termination kits suited to the installation environment in accordance with kit manufacturer's instructions.

D. Motor Connections

1. Unshielded conductor cables shall be made with insulated motor lead pigtail splice kits 3M 5300 Series 1kV with mechanical lugs as required. Install lug covers and mastic sealing tape per manufacturer's instructions.

2. The braided shields and internal grounding conductors of shielded cables shall be grounded at both ends with a termination kit provided by the manufacturer.

PART 3 - EXECUTION

3.1 CABLE INSTALLATION

A. Refer to Cable Schedule on the Drawings.

B. Conductor installation shall be in accordance with manufacturer's recommendations.

C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

D. Conceal cables in finished walls, ceilings and floors unless otherwise indicated.

E. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

F. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

G. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

H. Conductors within switchboards, panelboards, terminal cabinets, starters, control centers, etc., shall be neatly formed and trained to run parallel to or at right angles to the device. Conductors shall be bundled together and laced using nylon tie straps.

I. Control raceway and wiring shall be installed and fully connected to make system operational.

J. All interconnecting wiring shall be installed in approved conduit or cable trays and connected as shown on the Drawings. Unless otherwise shown or specified, all wiring shall be run in raceways see Section 26 05 33.

3.2 CONNECTIONS:

A. Conductor splices and connections shall be made with approved solderless lugs and mechanical connections to ensure positive electrically and mechanically strong joints. Use of connectors without internal spiral spring (wire nuts) is not acceptable.

B. Where bolted connectors are used for makeup of cables or for termination, they must be exact size to suit cable being used. Trimming, shimming or cutting of conductor strands are not permitted. Where branch circuit conduits are jointed or spliced using crimp-on or twist-on connectors, wires must first be twisted together full length and then connector installed.

C. 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.

D. Install splices or terminations as continuous operation in accessible locations under clean, dry conditions.

3.3 CONDUCTOR SIZING

A. Conductor sizes indicated in Division 26 documents are based on 75 degree copper unless specifically indicated otherwise on single-line diagram on drawings.

B. Power cable shall be minimum #12 AWG conductor, unless specifically indicated otherwise on Drawings.

C. Control cable shall be minimum #14 AWG single or multiple conductor cable with 600V insulation.

D. Unless specifically indicated otherwise on Drawings, provide grounded ("neutral") conductors that are at least parity-sized with corresponding phase/line conductors for all applications.

3.4 CIRCUIT IDENTIFICATION

A. Identify power, instrumentation, and control conductor circuits at each termination, and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.

B. Identify using circuit schedule designations as shown on the Drawings.

C. Method:

1. Conductors 3 AWG and Smaller: Identify with sleeves or heat bond markers.

2. Cables and Conductors 2 AWG and Larger:

a. Identify with marker plates or tie-on cable marker tags.

END OF SECTION 26 05 19

SECTION 26 05 26 – GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

A. Provide labor, material, equipment, related services, and supervision required, including, but not limited to installation, connections and testing of all grounding and bonding systems and accessories as required for the complete performance of the work, as shown on the Drawings, as specified herein.

1.2 RELATED SECTIONS

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

B. Division 26 Section "Common Work Results for Electrical".

1.3 REFRENCES

A. The equipment in this specification is designed and manufactured according to latest revision of the following standards (unless otherwise noted).

1. Institute of Electrical and Electronics Engineers (IEEE): C2, National Electrical Safety Code (NESC).

2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)

3. Underwriters Laboratories (UL)

1.4 SUBMITTALS

A. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.

B. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.

C. Manufacturer shall provide copies of following documents to owner for review and evaluation in accordance with general requirements of Division 1 and Division 26.

1. Product data on specified product documenting the following

a. Wire and cable.

b. Ground rods

c. Test wells

D. Provide a guarantee against defective materials and workmanship in accordance with requirements of the Section 26 05 00 of these Specifications.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

A. All ground conductors shall be at least 12 AWG soft drawn copper cable or bar, bare or green-insulated in accordance with the National Electrical Code.

B. Main service conduits, entering switchgear, panels, control center, switches, etc., shall be provided with insulating bushings with ground lug and connected to building ground system.

C. Bonding jumpers shall be copper tape, braided conductors, terminated with copper ferrules sized in accordance with the National Electrical Code table on sizes of equipment grounding electrode conductors.

D. All flexible conduits making final connections to motors, lights, vibrating equipment, etc., shall contain a green copper bonding conductor which shall extend from outlet box where flexible conduit originates or from nearest box in line to the equipment served.

2.2 GROUNDING RODS

A. Ground rods shall be a minimum of ⅝" in diameter by 10' long, with a copper jacket bonded to a steel core. Ground rods shall be UL listed and REA approved and shall conform to ANSI C33.8.

B. Where longer electrodes are necessary to reduce the ground resistance, Contractor shall provide sectional rods, connectors, drive heads, etc.

C. Connections between grounding conductors and grounding rods shall be mechanical if above ground, thermal if underground.

2.3 GROUNDING CONNECTIONS

A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Raco, O-Z/Gedney, Ercon, Square D, Brundy, or Thomas and Betts.

B. All grounding connections of copper to copper and copper to steel conductors of #8 and larger sized conductors shall be CADWELD exothermic welded connections. Conductors spliced with a CADWELD exothermic welded connection shall be considered as a continuous conductor, as stated in the notes accompanying NEC 250-50, 250-64, 250-68, 250-70 and IEEE 80.

C. All grounding connections to equipment shall use bolted lugs. When the conductor is #8 and larger, the lug shall be joined to the conductor by the CADWELD process, otherwise use listed compression lugs which meet IEEE 837.

D. Connections to equipment shall be by bolted compression type lugs (except for motors). When the conductor is #6 and larger, the lug shall be joined to the conductor by an exothermic weld connection.

E. Each cast pull box or junction box shall have a ground lug, connected to largest ground conductor to enter box.

2.4 TEST WELLS

A. Test wells and covers for non-traffic areas shall be molded high density polyethylene. Test wells for traffic areas shall be precast concrete construction rated for traffic duty with concrete or cast iron covers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment, building steel and main service must be effectively and permanently grounded with a cross section as required by the NEC and of capacity sufficient to ensure effectiveness of the ground connections for fault current.

B. Ground conductors must be as short and straight as possible and protected from mechanical injury, if practical, without splice or joint. Where practicable, ground conductors shall be routed to avoid bends exceeding 90 degrees or with a radius of less than 8”.

C. Raceways, boxes, outlets, cabinets, enclosures etc., shall be bonded together to form a continuous metallic grounding circuit in accordance with NEC.

D. All powered equipment, including lighting fixtures and receptacles, shall be grounded by a copper ground conductor in addition to the conduit connection.

E. Each receptacle and switch device shall be furnished with a grounding screw connected to the metallic device frame. Bond equipment grounding conductor to each outlet box. For isolated ground receptacles, bond equipment grounding conductor to box, and bond isolated ground conductor to device grounding screw.

3.2 ACCEPTANCE

A. Engineer or their representative shall observe the underground grounding system prior to burial.

B. Contractor shall measure the resistance between the main ground bonding jumper to true earth ground using the Fall of Potential method as described by ANSI/IEEE Standard 81 (“Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of an Earth System”). If the measured value is greater than five ohms, additional grounding electrodes shall be installed as needed.

END OF SECTION 26 05 26

SECTION 26 05 33 – RACEWAY AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. Provide labor, material, equipment, related services, and supervision required, including, but not limited to installation of boxes and routing all conduits including fittings, couplings, connectors, bushings, raceway hardware, conduit clamps and supports as required for the complete performance of the work, as shown on the Drawings, as specified herein.

1.2 RELATED SECTIONS

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

B. Division 26 Section "Common Work Results for Electrical".

1.3 REFRENCES

A. The equipment in this specification is designed and manufactured according to latest revision of the following standards (unless otherwise noted).

1. ANSI 77 – Specifications for Underground Enclosure Integrity
2. ASTM International (ASTM).
3. National Electrical Contractor’s Association, Inc. (NECA)
4. National Electrical Manufacturers Association (NEMA)
5. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)
6. Underwriters Laboratories (UL)

1.4 SUBMITTALS

A. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.

B. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.

C. Manufacturer shall provide copies of following documents to owner for review and evaluation in accordance with general requirements of Division 1 and Division 26.

1. Product data on and catalog sheets for all raceway and box components

a. Conduit

b. Wireways

c. Junction & Pull Boxes

d. Precast Manholes and Handholes

D. Provide a guarantee against defective materials and workmanship in accordance with requirements of the Section 26 05 00 of these Specifications.

PART 2 - PRODUCTS

2.1 CONDUIT AND TUBING

A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Allied, Atkore, Calbond, Cantex, Carlon, Centaur, Certinteed, Hubbell, Ocal, Plasti-Bond, Robroy, Southwire or Wheatland

B. Galvanized Rigid Steel Conduit (GRS):

1. Meet requirements of ANSI C80.1 and UL 6.

2. Hot-dip galvanized inside and out to provide galvanic corrosion protection. Also coated with a compatible organic layer to protect against white rust.

C. Rigid Aluminum Conduit (RAC):

1. Meet requirements of ANSI C80.5 and UL 6651.

2. Material: Type 6063 alloy in temper designation T-1.

D. PVC Schedule 80 Rigid Conduit:

1. Meet requirements of NEMA TC 2 and UL 651.

2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.

E. PVC-Coated Rigid Galvanized Steel Conduit:

1. Meet requirements of NEMA RN 1, ETL PVC-001 ANSI C80.1 and UL 6.

2. Material:

a. Exterior Finish: PVC coating, 40-mil nominal thickness.

b. Interior finish: Urethane coating, 2-mil nominal thickness.

c. Threads: Hot-dipped galvanized and factory coated with urethane.

d. Mounting hardware, which includes nuts, bolts, and anchors, shall be PVC coated or stainless steel.

F. Flexible Metal, Liquid-Tight Conduit:

1. Meet the requirements of UL 360.

2. Material: Galvanized steel with flexible PVC jacket.

a. UL 360 listed for -55 to 80 degrees C insulated conductors.

G. Flexible, Nonmetallic, Liquid-Tight Conduit:

1. Meet the requirements of ANSI 79 and UL 1660:

2. Material: PVC core with fused flexible PVC jacket.

a. Suitable for use at conduit temperatures of 80°C dry, 60°C wet

2.2 FITTINGS AND BUSHINGS

A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Appleton, Atkore, Calbond, Cantex, Carlon, Centaur, Certainteed, Crouse-Hinds, Hubbell, Killark, Meyers, O-Z/Gedney; a brand of the EGS Electrical Group, Ocal, Plasti-Bond, Raco, Robroy, Southwire, Thomas & Betts, Topaz, or Wheatland.

B. Galvanized Rigid Conduit

1. General:

a. Meet requirements of UL 514B, UL 467.

b. Type: Threaded, galvanized.

2. Bushing:

a. UL listed E-14814, and NEMA FB-1.

b. Materials: Zinc electroplated malleable iron with integral insulated throat,

3. Grounding Bushing:

a. UL listed E-6581, and NEMA FB-1.

b. Materials: Zinc electroplated malleable iron with integral insulated throat,

4. Conduit Hub:

a. UL listed E-11853, and NEMA FB-1, -4, and -12.

b. Materials: Zinc electroplated ductile iron with neoprene gasket and bonding screw.

c. UL listed for use in wet locations.

5. Conduit Bodies:

a. Sized as required by NEC.

b. UL listed E-2527, and NEMA FB-1.

c. Materials: Zinc electroplated malleable iron bodies and covers, stainless steel cover screws with neoprene gaskets

6. Couplings: As supplied by conduit manufacturer.

7. Unions:

a. Three-piece coupling

b. UL Listed: E-11853, and E-14817

c. Materials: Zinc electroplated malleable iron.

8. Conduit Sealing Fitting:

a. UL Standard 886, UL listed E1044, and E-34997 for use with Kwiko sealing compound.

b. Materials: Zinc electroplated malleable iron.

C. Rigid Aluminum Conduit

1. General:

a. Meet requirements of UL 514B.

b. Type: Threaded, copper-free.

2. Insulated Bushing:

a. UL listed E-11853, and NEMA FB-1.

b. Materials: Cast aluminum, with integral insulated throat

3. Grounding Bushing:

a. UL listed E-24264, and NEMA FB-1.

b. Materials: Cast aluminum with integral insulated throat with tin plated copper saddle.

4. Conduit Hub:

a. UL Listed: E-24264, E-11853, and NEMA FB-1.

b. Materials: Cast aluminum, with insulated throat and stainless steel ground screw.

c. UL listed for use in wet locations.

5. Conduit Bodies:

a. UL Listed: E-2527, and NEMA FB-1.

b. Materials: Copper free aluminum, neoprene gasket and stainless steel screws.

6. Couplings: As supplied by conduit manufacturer.

7. Conduit Sealing Fitting, Drain Seal:

a. UL Standard 886, UL listed E1044, and E-34997 for use with Kwiko sealing compound.

b. Materials: Copper free aluminum

8. Drain/Breather Fitting:

a. UL Listed: E-34997.

b. Materials: Copper free aluminum

9. Expansion Fitting:

a. UL Listed for use in wet locations

b. Materials: Copper free aluminum

D. PVC Schedule 40 Rigid Conduit and Tubing:

1. Meet requirements of NEMA TC 3.

2. Type: PVC, slip-on.

E. PVC-Coated Rigid Galvanized Steel Conduit:

1. Meet requirements of UL 514B.

2. Fittings: Rigid galvanized steel type, PVC coated by conduit manufacturer.

3. Conduit Bodies: Cast metal hot-dipped galvanized or urethane finish. Cover shall be of same material as conduit body. PVC coated by conduit manufacturer.

4. Finish: 40-mil PVC exterior, 2-mil urethane interior.

5. PVC-coated conduit hangers, attachments, and accessories.

6. Expansion fitting:

   a. UL Listed

   b. Materials: Steel with PVC coating

   c. Finish: 40-mil PVC exterior, 2-mil urethane interior.

   d. Internal grounding system

F. Flexible Metal, Liquid-Tight Conduit:

1. UL Listed E-23018, and NEMA FB-1.

2. Metal insulated throat connectors with integral nylon or plastic bushing

3. Insulated throat and sealing O-rings.

4. Materials: malleable iron with Zinc Chromate finish

G. Flexible, Nonmetallic, Liquid-Tight Conduit:

1. Meet requirements of UL 514B.

2. Tapered thread hub and furnished Neoprene sealing O-ring provide a liquid-tight, dust-tight seal to a box or enclosure

H. Flexible Coupling, Hazardous Locations:

1. Approved for use in atmosphere involved.

2. Meet requirements of UL 668, UL Listed E-34997

3. Rating: Watertight and UL listed for use in Class I, Division 1 and 2 areas.

4. Materials: Outer bronze braid, inner brass core with insulating liner.

5. Electrical conductivity equal to rigid conduit on a similar length basis. No bonding jumper required.

I. Watertight Entrance Seal Device:

1. New Construction:

a. Bodies and pressure clamps are high strength malleable or ductile iron coated with a high organic zinc sacrificial conductive epoxy coating.

b. Pressure rings are closely sized to fitting inside diameter and outside diameter of casing. They are thick steel plates that have a heavy durable PVC coating, utilizing the very effective fluid bed process.

c. Bolts are hex head cap bolts zinc electroplated.

d. Neoprene sealing grommets are molded or drilled to accommodate casing outside diameters.

e. Oversize sleeves have a marker strip to facilitate field cutting of sleeves to accommodate walls or floors of varying thicknesses.

2. Cored-Hole Application:

a. Conduit sealing bushings are used to seal against fluid and gas pressure around mechanical pipes, casing, conduits or tubes.

b. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.

2.3 OUTLET BOXES

A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Appleton, Centaur, Crouse-Hinds, Killark, Lew Electric, Raco, Steel City, Square D, or Thomas and Betts.

B. Sheet Metal Outlet Boxes:

1. Meet requirements of UL 514A, and NEMA OS-1.

2. Material: galvanized steel, with ½ inch male fixture studs where required.

C. Cast Aluminum

1. Meet the requirements of UL 514A, and NEMA FB-1. UL listed E-3397.

2. Material: Box shall be powder coated cast copper-free aluminum. The cover shall be powder coated cast copper-free aluminum gasketed and weatherproof with stainless steel screws.

D. PVC Coated Cast Metal

1. Materials: Cast metal hot-dipped galvanized or urethane finish. Cover shall be of same material as conduit body. PVC coated by conduit manufacturer.

2. Finish: 40-mil PVC exterior, 2-mil urethane interior.

E. Floor Boxes

1. UL 514A 4.25” x 4.25” x 3” back box for floor pop up receptacles.

2.4 JUNCTION AND PULL BOXES

A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Austin Electrical Enclosures, Crouse Hinds, Eaton, Hoffman, Killark, Neenah, O-Z/Gedney, Saginaw, or Square D.

B. General

1. Pull boxes no less than the minimum size required by the National Electrical Code Article 314 Interior junction boxes shall be galvanized or powder coated steel. Boxes located on the exterior of the structures or in harsh environments shall be watertight and constructed of cast aluminum with gasketed covers. Boxes shall be furnished with screw fastened covers.

C. Sheet metal boxes

1. NEMA 250, Type 1, code-gauge, galvanized steel. The cover shall full access, screw type. Boxes larder than 12” shall be provide with hinged covers. Corrosion resistant machine screws.

D. Cast metal boxes

1. Cast malleable iron or ferrous metal, electrogalvanized finished or aluminum, NEMA 250, enclosure rating as shown on the Drawings or per environment classification table below. Box will have drilled and tapped conduit entrances and exterior mounting lugs. The cover shall be hinged with a neoprene gasket and stainless steel hardware and screws.

2. Provide recessed flange cover for outdoor use rated for installed traffic area, pedestrian, vehicle etc.

2.5 WIREWAYS

A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Austin Electrical Enclosures, Eaton, Hoffman, or Square D.

B. Meet the requirements of UL 870.

C. Enclosure rating as shown on the Drawings or per environment classification table below.

D. 14 Gauge steel wireway without knockouts, unless noted otherwise

E. Hinged or screw applied cover with full gasketing.

F. Finish: Gray polyester powder coat.

2.6 PRECAST MAN HOLE AND HAND HOLES

A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Armorcast, Foley Products, J&H American Enclosures, Oldcastle, or Qualzite.

B. Precast Concrete Electric Manhole: Precast concrete electrical manholes shall include thin-wall knockout, cable racks, pull irons, sump box with grate, ground rod sleeve, risers, where required, and a ductile iron frame and cover marked “ELECTRIC.”

C. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Handholes and boxes shall be molded sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

2.7 ACCESSORIES

A. Fittings and accessories:

1. Include couplings, offsets, elbows, expansion joints, adapters, hold down straps, end caps, and other fittings to match and mate with wire ways required for complete system. All couplings and connections in locations where water or other liquid or vapor might contact the conduit shall be watertight.

B. Duct sealant:

1. Duct seal putty shall be a gray, permanently soft, non-toxic compound which will adhere to most clean dry surfaces. It shall not adversely affect other plastic materials or corrode metals. Duct seal putty manufacturer shall be Rainbow Technology, Gardner Bender, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION AND APPLICATION

A. Raceways

1. Keep raceways at least 12" away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.

2. Complete raceway installation before starting conductor installation.

3. All raceway stubs shall be sufficiently plugged or capped during construction to prevent entry of water, debris, mortar, etc.

4. Where non-metallic PVC plastic conduit is installed underground in groups of 3 or more, it shall be installed in duct banks as indicated on the Drawings or where noted otherwise. Duct banks shall be encased in 3,000 psi concrete.

5. All conduits entering boxes, cabinets, panels of similar equipment shall have double locknuts and insulating bushing.

6. A code sized grounding conductor shall be installed in all raceways.

7. All raceways shall be rigidly supported from building structure by rods or hangers attached to building structure. Raceways shall not be attached to any rods or hangers required by other trades. Raceways shall be supported from building construction at intervals as required by the NEC not to exceed 8' with straps and expansion bolts for masonry or concrete construction.

8. All raceways entering cabinets, panels, switchboxes, switchgear, junction boxes, etc. shall be fitted with double bonding locknuts and bushings. One locknut inside and one outside box shall be used. Where conduits terminate in steel or cast NEMA enclosures with no factory installed threaded hubs, a threaded hub shall be installed.

9. Feeder cable conductors shall be pulled into raceways using an approved lubricant. Pull conductors with a pulling eye attached to conductor so not to stretch or injure insulation.

10. Contractor shall be responsible for coordinating proper connection at each item of equipment requiring service and connect accordingly. The term “stub-up and connect” or “connect” used on Drawings implies a full connection as required for each piece of equipment to place it in satisfactory operation. If equipment is equipped with cord and plug, install proper matching receptacle.

11. Conceal conduit within finished walls, ceilings and floors unless otherwise indicated. Install concealed raceways with a minimum of bends in the shortest practical distance considering type of building construction and obstructions, unless otherwise indicated.

12. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200 pound tensile strength. Leave at least 36" of slack at each end of pull wire.

13. Install watertight fittings in outdoor, underground, or wet locations.

14. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

15. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

16. Install conduits for fiber optic cables, telephone cables, and Category 6 data cables in strict conformance with the requirements of TIA 569B.

17. Galvanized Rigid Conduit

    a. Rigid steel shall be used for all underground and indoor dry (Lab Building, and Electrical Building) signal raceways. “Signal raceways” shall include all 4/20mA, RS-485, Ethernet, and Fiber Optic signals. See duct bank schedule on the Drawings for details.

18. Rigid Aluminum Conduit

    a. Rigid aluminum shall be used for all exposed raceways except as otherwise noted.

    b. Exposed conduit shall be rigidly supported by stainless steel or aluminum hardware and framing materials.

    c. All aluminum conduit installed in contact with concrete or earth shall be protected with aluminum bitumastic paint or tape wraps approved for the purpose.

19. PVC Schedule 40 Rigid Conduit and Tubing:

    a. Use for underground power feeders and branch circuits or where located in interior concealed walls, or ceilings except as otherwise noted and where specifically indicated on Drawings.

    b. A grounding conductor shall be installed in each non-metallic conduit to maintain grounding continuity.

    c. Follow manufacturer’s recommendations for heat bends and cement application. Install plastic to metallic adapter before emerging from ground or running under building.

    d. Install expansion fittings for each 100' of unbroken PVC run.

20. PVC-Coated Rigid Galvanized Steel Conduit:

    a. Use for all exposed outdoor signal raceways and conduit in corrosive environments (Headworks, Aeration Basin, Final Clarifiers, Chemical Feed Building and Sludge Dewatering Building).

    b. All damaged coatings shall be repaired according to the manufacturer's instructions.

21. Flexible Metal, Liquid-Tight Conduit

    a. Use for final connections, maximum 72", to all dry-type transformers, motors, vibrating equipment and in wet or damp installations.

    b. In all liquid-tight flexible steel conduit, provide a green grounding conductor sized per NEC. Bond at fixture, motor, etc., and also bond at box where flexible conduit originates or the next box in line.

B. Junction, pull boxes and wireways

1. 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.

2. Concealed conduit systems shall have flush-mounted switches and convenience outlets. Exposed conduit systems shall have surface-mounted switches and convenience outlets. Conduits shall be concealed where practicable.

3. Exterior boxes and outlets shall be securely attached to building structure using expansion bolts for masonry or concrete construction.

4. Covers and collars for manholes shall be level with the finished grade. Build up masonry wall between manhole top and manhole cover collar as required for leveling with finished grade.

Location	Enclosure Type
Indoor dry areas (Lab and Electrical building)	NEMA 1
Wet or corrosive indoor areas (Sludge Building, Chemical Feed Building)	NEMA 4X SS
Outdoor (Headworks, Aeration Basin, Clarifiers, & UV Disinfection)	NEMA 4X SS
Class 1, Division 2	NEMA 7

C. Receptacles

1. Receptacles shall be installed vertically 1'-4" above the floor except as noted otherwise.

2. Outlets outdoors and in garages, basements, shops, storerooms, and rooms where equipment may be hosed down; shall be 4' above floor or grade.

3. Conduit and wire for receptacle installation not shown on the Drawings shall be, sized, furnished and installed by Contractor. Conductors shall be minimum 12 AWG, and conduit shall be minimum ¾" for convenience outlet installation.

4. Install devices and assemblies level, plumb and square with building lines.

5. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

6. Cover Plates

   a. Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

   b. Remove wall plates and protect devices and assemblies during painting.

END OF SECTION 26 05 33

SECTION 26 05 73 – SHORT CIRCUIT / COORDINATION STUDY

PART 1 - GENERAL

1.1 SCOPE

A. The contractor shall furnish short-circuit and protective device coordination studies which shall be prepared by the equipment manufacturer.

1.2 RELATED SECTIONS

A. Section 16016 – Arc Flash Hazard Analysis Study

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
5. IEEE 1015 – Recommended Practice for Applying Low Voltage Circuit Breakers Used in Industrial and Commercial Power Systems

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformer
2. ANSI C37.13 – Standard for Low Voltage ac Power Circuit Breakers Used in Enclosure
3. ANSI C37.010 – Standard Application Guide for ac High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4. ANSI C37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories
5. ANSI C37.5 – Methods for Determining the RMS Value of a Sinusoidal Current Wave and Normal-Frequency Recovery Voltage, and for Simplified Calculation of Fault Currents

C. The National Fire Protection Association 70, National Electrical Code, latest edition.

1.4 SUBMITTALS FOR REVIEW/APPROVAL

A. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.5 SUBMITTALS FOR CONSTRUCTION

A. The results of the short-circuit and coordination studies shall be summarized in a final report. Submit five (5) bound copies of the final report. Additional copies, where required, shall be provided on CD in PDF format.

B. The report shall include the following sections:

1. One-line diagram showing protective device ampere ratings and associated designations, cable size & lengths, transformer kVA & voltage ratings, motor & generator kVA ratings, and switchgear/switchboard/panelboard designations
2. Descriptions, purpose, basis and scope of the study
3. Tabulations of the worst-case calculated short circuit duties as a percentage of the applied device rating (automatic transfer switches, circuit breakers, fuses, etc.); the short circuit duties shall be upward-adjusted for X/R ratios that are above the device design ratings
4. Protective device time versus current coordination curves with associated one line diagram identifying the plotted devices, tabulations of ANSI protective relay functions and adjustable circuit breaker trip unit settings
5. Fault study input data, case descriptions, and current calculations including a definition of terms and guide for interpretation of the computer printout
6. Comments and recommendations for system improvements, where needed
7. Executive summary

1.6 QUALIFICATIONS

A. The short-circuit and coordination studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting power system studies. The Registered Professional Electrical Engineer shall be a full-time employee of the Engineering Services Organization.

PART 2 - PRODUCTS

2.1 STUDIES

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer.

2.2 DATA COLLECTION

A. Contractor shall furnish all field data as required by the power system studies. The Engineer performing the short-circuit and coordination studies shall furnish the Contractor with a listing of required data. The Contractor shall expedite collection of the data to eliminate unnecessary delays and ensure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source contribution may include present and future utility supply, motors, and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner or Contractor.

D. Include fault contribution of existing motors in the study, with motors < 50 hp grouped together. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use typical conductor impedances based on IEEE Standard 141, latest edition.

B. Transformer design impedances and standard X/R ratios shall be used when test values are not available.

C. Provide the following:

1. Calculation methods and assumptions
2. Selected base per unit quantities
3. One-line diagram of the system being evaluated
4. Source impedance data, including electric utility system and motor fault contribution characteristics
5. Typical calculations
6. Tabulations of calculated quantities
7. Results, conclusions and recommendations

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:

1. Electric utility's supply termination point
2. Incoming switchgear
3. Unit substation primary and secondary terminals
4. Low voltage switchgear
5. Motor control centers
6. Standby generators and automatic transfer switches
7. Branch circuit panelboards
8. Other significant locations throughout the system

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Protective device evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings
2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
3. Adequacy of transformer windings to withstand short-circuit stresses
4. Cable and busway sizes for ability to withstand short-circuit heating
5. Notify Owner in writing of existing circuit protective devices improperly rated for the calculated available fault current

2.4 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.

B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay and instantaneous settings recommended.

E. Plot the following characteristics on the curve sheets, where applicable:

1. Electric utility's protective device

2. Medium voltage equipment relays
3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance and damage bands
4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
5. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
6. Conductor damage curves
7. Ground fault protective devices, as applicable
8. Pertinent motor starting characteristics and motor damage points
9. Pertinent generator short-circuit decrement curve and generator damage point
10. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor control center

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.5 REPORT SECTIONS

A. Input Data:

1. Utility three-phase and line-to-ground available contribution with associated X/R ratios
2. Short-circuit reactance of rotating machines with associated X/R ratios
3. Cable type, construction, size, # per phase, length, impedance and conduit type
4. Bus duct type, size, length and impedance
5. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance and X/R ratio
6. Reactor inductance and continuous ampere rating
7. Aerial line type, construction, conductor spacing, size, # per phase, and length

B. Short-Circuit Data:

1. Source fault impedance and generator contributions
2. X to R ratios
3. Asymmetry factors
4. Motor contributions
5. Short circuit kVA
6. Symmetrical and asymmetrical fault currents

C. Recommended Protective Device Settings:

1. Phase and Ground Relays:
    a. Current transformer ratio
    b. Current setting
    c. Time setting
    d. Instantaneous setting
    e. Specialty non-overcurrent device settings
    f. Recommendations on improved relaying systems, if applicable
2. Circuit Breakers:
    a. Adjustable pickups and time delays (long time, short time, ground)
    b. Adjustable time-current characteristic
    c. Adjustable instantaneous pickup
    d. Recommendations on improved trip systems, if applicable

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make minor modifications to equipment as required to accomplish conformance with short-circuit and protective device coordination studies.

C. Notify Owner in writing of any required major equipment modifications.

D. Following completion of all studies, acceptance testing and startup by the field engineering service division of the equipment manufacturer, a 2-year warranty shall be provided on all components manufactured by the engineering service parent manufacturing company.

END OF SECTION 26 05 73

SECTION 26 22 13 – LOW VOLTAGE TRANSFORMERS

PART 1 - GENERAL

A. Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, configuration and installation for low voltage distribution dry-type transformers (also identified as transformer, XFMR or T) as required for the complete performance of the work, as shown on the drawings, as specified herein.

B. RELATED SECTIONS

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

2. Division 26 Section "Common Work Results for Electrical".

1.2 REFRENCES

A. The equipment in this specification is designed and manufactured according to latest revision of the following standards (unless otherwise noted).

1. ANSI/IEEE C57.96, Distribution and Power Transformers, Guide for Loading Dry-Type appendix to ANSI C57.12 standards

2. IEEE C57.12.01, General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid Cast and / or Resin-Encapsulated Windings

3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)

4. IEEE C57.12.91, Test Code for Dry-Type Distribution and Power Transformers

5. NEMA ST 20, Dry Type Transformers for General Applications

6. UL 1561, Dry type General Purpose Power Transformer

7. Efficiency level DOE 2016 by 10 CFR PART 431

1.3 DEFINITIONS

A. Unless specifically defined within the Contract Documents, the words or acronyms contained within this specification shall be as defined within, or by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.

1. Low-voltage dry-type distribution transformer:

a. Has an input voltage of 600V or less

b. Has an output voltage of 600V or less

c. Covers Step-up and Step- down transformers

d. Is rated for operation at a frequency of 60 Hz

e. 15 kVA to 1000 kVA for dry-type units

f. Is air-cooled; and

g. Does not use oil as a coolant

1.4 SUBMITTALS

A. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.

B. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.

C. Manufacturer shall provide copies of following documents to owner for review and evaluation in accordance with general requirements of Division 1 and Division 26.

1. Product data on specified product documenting the following

a. Dimensions

b. Weight

c. KVA

d. Voltage

e. Taps

f. Insulation Class

g. Sound level

h. Wiring Diagram

i. Installation Instructions available per request

1.5 PROJECT RECORD DRAWINGS

A. Maintain an up-to-date set of Contract documents. Note any and all revisions and deviations that are made during the course of the project.

B. Provide final typical outline drawing

1.6 OPERATION AND MAINTENANCE DATA

A. Manufacturer shall provide copies of installation, operation and maintenance procedures to owner in accordance with general requirements of Division 1 and Division 26.

B. Submit operation and maintenance data based on factory and field testing, operation and maintenance of specified product.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of ten years.

1. The manufacturer shall have a valid ISO 9001 certification and an applicable quality assurance system that is regularly reviewed and audited by a third-party registrar. Manufacturing, inspection, and testing procedures shall be developed and controlled under the guidelines of the quality assurance system.

B. All work performed and all materials used shall be in accordance with the National Electrical Code, and with applicable local regulations and ordinances. Equipment, assemblies and materials shall be listed and labeled by Underwriter's Laboratories or by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products in accordance with the manufacturer recommendations.

B. Dry type transformers shall be located in well-ventilated areas, free from excess humidity, dust and dirt and away from hazardous materials. Indoor locations shall be protected to prevent moisture from entering enclosure.

C. Equipment shall be shipped with edge and top protection that is adequate to protect the transformer enclosure from common dents and scratches.

1.9 WARRANTY

A. Manufacturer warrants equipment to be free from defects in materials and workmanship for 1 year from date of installation or 18 months from date of purchase, whichever occurs first.

PART 2 - PRODUCTS

2.1 CONDUIT AND TUBING

2.1 MANUFATURER

A. GE by ABB products have been used as the basis for design. Other manufactures' products of equivalent quality, dimensions and operating features may be acceptable, at the Engineer's discretion, if they comply with all requirements specified.

B. Other pre-approved manufacturers.

1. Square D

2. Eaton

2.2 GENERAL REQUIREMENTS

A. Dry type general purpose transformers shall be rated as indicated in the drawings

B. Comply with NEMA ST 20, and list and label as complying with UL 1561

C. Cores: One leg per phase

D. Enclosure: Ventilated, NEMA 250, Type 2 for indoor locations, Type 3R for outdoor locations.

E. Transformers supplied to this specification shall be able to operate continuously at 100 percent nameplate rating at ambient temperature not exceeding 40 degrees C.

F. Insulation Class: 220 degrees C, UL recognized insulation system with a maximum of 150, 115 or 80 deg C rise above 40 deg C ambient temperature. Temperature rise ratings shall be in accordance with UL 1561.

G. Transformer shall have self-cooled sound levels equal to or lower than those established by ANSI/IEEE

Equivalent Winding KVA range	**K-Factor 1** **K-Factor 4** **K-Factor 9**	**K- Factor 13** **K-Factor 20**
9.00 and below	40	40
9.01 to 50.00	45	48
50.01 to 150.00	50	53

150.01 to 300.00	55	58
300.01 to 500.00	60	63
500.01 to 700.00	62	65
700.01 to 1000.00	64	67

H. Transformer shall be sound tested in the factory prior to shipment. A record of the sound testing can be obtained from the manufacturer upon request (additional cost applies).

I. Transformers shall meet the energy efficiency requirements of 10 CFR PART 431 2016.

Single-phase	
kVA	**Efficiency (%)**
15	97.70
25	98.00
37.5	98.20
50	98.30
kVA	**Efficiency (%)**
75	98.50
100	98.60
167	98.70
250	98.80
333	98.90

Three-phase	
kVA	**Efficiency (%)**
15	97.89
30	98.23
45	98.40

75	98.60
112.5	98.74
150	98.83
225	98.94
300	99.02
500	99.14
750	99.23
1000	99.28

J. Transformers shall carry the fully rated load continuously when the surrounding air does not exceed 30ºC/86F, 40ºC/140F maximum and adjacent structures do not prohibit the free movement of cooling air according installation manual.

K. Transformers 5 KVA and above shall be able to meet ANSI/IEEE C57.96 daily overload requirements listed in drawings. Transformers loaded in accordance with this paragraph shall be capable of long service life under thermal conditions specified. There shall be no need for derating.

L. Enclosures shall meet UL 506 requirements for the following characteristics:

1. Ventilation Openings;

2. Corrosion Resistance;

3. Cable Bending Space;

4. Surface Temperature Rise;

5. Wiring Compartment Temperature Rise;

6. Terminations.

7. Brushed Stainless Steel 316 available for capacities 15 to 150 kVA

M. Transformer Construction

1. Transformer core shall be constructed of high grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Magnetic flux densities shall be kept well below core saturation point. Transformer core shall be clamped by bolts through the core laminations to provide consistent pressure throughout

the core length. Completed core and coil shall be bolted to enclosure base and isolated from base by rubber vibration-absorbing mounts.

2. Transformer core shall be visibly grounded to enclosure.

3. Enclosure shall be constructed of heavy gauge steel.

4. Coils shall be copper.

2.3 ACCESSORIES

A. Accessories for 15 kVA to 500 kVA are available as spare parts or as additional feature:

1. Weathershield kits.

2. Front kit

3. Side kit

4. Cover kit

5. Lug kits

6. Enclosure kit

7. Bottom pan kit

B. Accessories included in transformers from 15 kVA to 150 kVA (Except for Stainless steel or special transformers)

1. Lug kits

2. Ground kits

C. Accessories for transformers from 15 kVA to 112.5 kVA should be available as additional option.

1. Wall mounting brackets

D. Accessories included in transformers from 15 kVA to 500kVA

1. Isomode pad kit

2.4 LOAD TAPS

A. Transformers shall have following high voltage load tap arrangements unless noted otherwise in plans:

1. Taps for transformers smaller than 3 KVA - no taps;

2. Taps for transformers 3 through 25 KVA - [no taps] [2, 5 percent taps, both below nominal voltage] [4, 2-1/2 percent taps, 2 above, 2 below nominal voltage];

3. Taps for transformers 25 kVA to 300 KVA – Two 2.5 percent taps above and four 2.5 percent below normal full capacity.

4. Taps for transformer 500 KVA - Two 2.5 percent taps above, 2 below nominal voltage

5. Taps for 750 KVA – one tap above and one tap below at 5 percent of the nominal voltage

2.5 TESTING

A. Transformers furnished to this specification shall receive the following production tests:

1. Applied Potential

2. Induced Potential

3. No Load Losses

4. Voltage Ratio

5. Polarity

6. Continuity

B. Manufacturer shall perform the following additional tests on units identical to the design type being supplied to this specification. Manufacturer shall provide on request test data sheets to prove performance of these tests.

1. Sound Levels

2. Temperature Rise Tests

3. Full-Load Losses

4. Regulation

5. Impedance

2.6 MARKINGS AND LABELING

A. All identification, warning labels and nameplates mounted on the exterior shall be resistant to weather, UV, and their intended installation environment.

B. Nameplate shall contain the minimum information required by latest version of NEC and NEMA ST-20 and be part of a UL Component Recognized outdoor marking system

C. Other information shall also be supplied

1. Efficiency Level @ 35% loading correct for 75°C temperature

2. DOE 10 CFR 429 Data base identifier

3. Statement on Nameplate identifying that it is a Distribution Transformer, or why it is not

    a. Meets Final Rule US 10 CFR 431 April 2013

2.7 Warning labels and nameplates shall be present at access locations to advise personnel of possible hazards.

2.8 FINISH

A. Finish shall consist of coated powder paint ANSI 61 gray.

PART 3 - EXECUTION

3.1 GENERAL

A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of Specification Division 26 and Drawings.

3.2 EXAMINATION

A. Examine equipment exterior and interior prior to installation. Report any damage and do not install any equipment that is structurally, moisture, or mildew damaged.

B. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

C. Verify field measurements are as instructed by manufacturer.

D. Electrical Contractor to verify that required utilities are available.

E. Electrical Contractor has obtained all necessary data to install the unit.

3.3 LOCATION

A. Electrical Contractor to verify proper location for the unit.

B. The transformer shall be installed in a location where the sides with ventilated openings are a minimum distance of six inches from noncombustible structures or equipment to ensure adequate air circulation.

3.4 INSTALLATION

A. If transformer needs to be stored, follow manufacture instructions – (storage shall also include after installation, if units are not immediately energized)

1. During storage make sure all ventilated openings do not allow for dust or other debris to enter transformers

2. Transformer cannot be stored outdoors, even if Type 3R, without maintaining uniform temperature above dew point

B. Mount transformers per drawings, location shall be readily accessible. When mounted on walls, columns, or other support structure in visible site are not required to be readily accessible.

1. Verify that minimum distance from rear and side are in compliance with manufacture drawings and information on nameplate

C. Using Flexible raceways, conduits, and connectors – connected in locations identified by manufacture drawings or instruction manuals

D. Land wire on proper terminals, tight all connections via calibrated torque wrench

E. Grounding – comply with Electrical Code and manufacturer's instructions

1. Ground Bar or Ground Bus

2. Verify that core assembly is factory grounded to enclosure

F. Bonding – comply with Electrical Code and manufacturer's instructions

G. In accordance with NEC Section 450-9, allow at least 6 inches clearance for ventilation.

3.5 FIELD QUALITY CONTROL

A. Inspect installed dry type transformers for anchoring, alignment, grounding and physical damage.

B. Check tightness of all accessible mechanical and electrical connections with calibrated torque wrench. Minimum acceptable values are specified in manufacturer's instructions.

3.6 TESTING

A. Established safety procedures shall be followed including but not limited to

1. Proper Personal Protective Equipment, accordance with incident energy levels

B. Megger Transformer to verify all connections are cleared from ground

C. Take Measurements of Primary Voltages – match nameplate

D. Take Measurements of Secondary Voltages – match nameplate

E. With front cover installed verify that the transformer when energized is not emitting excess if noise – contact manufacture if noise is not 120 hertz constant hum

3.7 CLEANING

A. Repaint scratched or marred exterior surfaces to match original finish.

END OF SECTION 26 22 13

SECTION 26 24 16 – PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, configuration and installation for lighting and appliance panelboards or power panelboards as required for the complete performance of the work, as shown on the drawings, as specified herein, and as specified elsewhere for the assemblies or systems comprised of the components specified herein.

1.2 RELATED SECTIONS

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

B. Division 26 Section "Common Work Results for Electrical".

C. Section 26 28 11 Molded Case Circuit Breakers

1.3 REFRENCES

A. The lighting and appliance panelboards or power panelboards and protection devices in this specification are designed and manufactured according to latest revision of the following standards (unless otherwise noted).

1. NEMA AB 1, "Molded Case Circuit Breakers and Molded Case Switches."

2. ANSI/NEMA PB 1, Panelboards

3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)

4. ASTM - American Society of Testing Materials

5. CSA C22.2 No. 29, Panelboards and Enclosed Panelboards

6. CSA C22.2 No. 5.1, Molded Case Circuit Breakers

7. Federal Specification W-C-375, Rev. B, Amend. 1, Circuit Breakers, Molded Case; Branch Circuit and Service

8. Federal Specification W-P 115, Rev. C, Panel, Power Distribution

9. NEMA AB 1, Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures

10. ANSI/NEMA PB 1.1, General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less

11. UL 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures

12. UL 50, Enclosures for Electrical Equipment, Non-Environmental Considerations

13. UL 67, Panelboards

1.4 SYSTEM DESCRITPION

A. Lighting and appliance panelboards or power panelboards shall be suitable for use on power systems with nominal voltage ratings and short circuit current ratings indicated on drawings.

B. Short circuit rating of lighting and appliance panelboards or power panelboards shall be the interrupting rating of lowest rated device in the panel or applicable UL series rating for proper main and branch device combinations.

C. Panelboard breakers shall be plug-in style with at least one bolt to attach the breaker to panelboard structure. Conventional bolt-on style breakers are also acceptable.

D. Protective devices shall be molded case circuit breakers (MCCB).

1.5 SUBMITTALS

A. Manufacturer shall provide copies of following documents to owner for review and evaluation in accordance with general requirements of Division 1 and Division 26:

B. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.

C. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.

D. Product Data on specified product;

E. Shop Drawings on specified product;

1.6 PROJECT RECORD DRAWINGS

A. Maintain an up-to-date set of Contract documents. Note any and all revisions and deviations that are made during the course of the project.

1.7 OPERATION AND MAINTENANCE DATA

A. Manufacturer shall provide copies of installation, operation and maintenance procedures to owner in accordance with general requirements of Division 1 and Division 26.

B. Submit operation and maintenance data based on factory and field testing, operation and maintenance of specified product.

1.8 QUALITY ASSURANCE

A. Manufacturer shall have specialized in the manufacture and assembly of lighting and appliance panelboards or power panelboards for 50 years.

B. Lighting and appliance panelboards or power panelboards shall be listed and/or classified by Underwriters Laboratories in accordance with standards listed in Article 1.3 of this specification.

C. Installer has specialized in installing power panelboards.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products in accordance with recommended practices in manufacturer's Installation and Maintenance Manuals.

B. Deliver each lighting panelboard in individual shipping cases for ease of handling. Each panelboard shall be wrapped for protection.

C. Installer shall inspect and report concealed damage to carrier within specified time.

D. Store in a clean, dry space. Maintain factory protection or cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. (Heat enclosures to prevent condensation.)

E. Handle in accordance with NEMA and manufacturer's written instructions to avoid damaging equipment, installed devices, and finish.

1.10 PROJECT CONDITIONS

A. Follow (standards) service conditions before, during and after panelboard installation.

B. Lighting and appliance panelboards or power panelboards shall be located in well-ventilated areas, free from excess humidity, dust and dirt and away from hazardous materials. Ambient temperature of area will be between minus 5 and plus 40 degrees C. Indoor locations shall be protected to prevent moisture from entering enclosure.

1.11 WARRANTY

A. Manufacturer warrants equipment to be free from defects in materials and workmanship for 1 year from date of installation or 18 months from date of purchase, whichever occurs first.

1.12 FIELD MEASUREMENTS

A. Make all necessary field measurements to verify that equipment shall fit in allocated space in full compliance with minimum required clearances specified in National Electrical Code.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. General Electric by ABB ReliaGear or equal by Schneider or Eaton.

2.2 COMPONENTS

A. Refer to Drawings for: actual layout and location of equipment and components; current ratings of devices, bus bars, and components; voltage ratings of devices, components and assemblies; and other required details.

B. Ratings

1. Lighting and appliance panelboards or power panelboards shall be rated as indicated in drawings.

2. Maximum current ratings for mains and feeders, respectively, shall be specified in drawings.

C. Enclosure

1. Enclosure shall be as indicated on Drawings.

2. All panelboard series ratings shall be prominently displayed on dead front shield.

3. Interiors shall permit top or bottom incoming cables.

D. Bus bars

1. Bus bars shall be phase sequenced, fully insulated, and finger safe.

2. Bus bars shall be mechanically supported to prevent vibration and damage from short circuits.

3. Terminations shall be UL tested and listed and suitable for conductors furnished.

4. Lugs shall be rated for 75 degree C terminations.

E. Circuit Breakers – General Requirements

1. Molded case circuit breakers shall be bolt-on.

2. MCCBs may be thermal magnetic or solid state as required for the particular application.

3. All breakers shall have handle trip indication.

4. Breaker handle and faceplate shall indicate rated ampacity.

5. Circuit breaker escutcheon shall have standard ON/OFF markings.

F. Main and Circuit Breakers

1. Main circuit breakers may be vertically or horizontally mounted.

2. Main breakers shall be UL listed for use with: Mechanical Lug Kits.

3. Main breakers in panels rated up to 1200A shall have fixed thermal magnetic trip units or adjustable thermal magnetic trip units or adjustable solid state trip units.

2.3 ACCESSORIES

A. Locking devices for breakers and or operating handles if indicated on drawings

B. Furnish nameplates for each device as indicated in drawings. Color schemes shall be as indicated on drawings.

C. Provide an integrally mounted surge protective device (SPD) where indicated on drawings. Device shall be ABB TPHE Series or TPME Series SPDs, or equal by Schneider or Eaton that complies with all of the following.

1. SPD shall be factory installed as an integral part of the panelboard, complying with UL 1449 SPD, Type 2, with the following features and accessories:

a. SPD Ratings

1) Maximum Single Impulse Surge Current Rating shall be 100 kA per mode and shall be based on the testing of a complete SPD including fuses and all components that make up the SPD assembly using an IEEE C62.41, 8x20us current wave applied at the maximum, per mode rated value of the SPD. Devices that derive a per mode rating by adding test results of individual components are not acceptable.

2) Surge Life Rating shall be a minimum of 5,000 IEEE C62.41 C-High (C3) impulses and shall be determined by the application of an 8x20us, 10kA short circuit Category C High test waveform across the SPD as defined by ANSI/IEEE C62.41.2-2002. The test wave shall be injected at one-minute intervals until the conclusion of the test or device failure. A failure is defined as either performance degradation or more than 10% deviation of clamping voltage at the specified surge current.

3) UL 1449 Nominal Discharge Current Rating (In): 20kA

b. The SPD shall be provided with the following features:

1) Internal thermal protection that disconnects the SPD before damaging internal suppressor components.

2) Indicator light display for protection status.

3) Form-C contacts rated at 5-A and 250-V ac, one N.O. and one N.C., for remote monitoring of protection status.

4) Surge counter

2.4 FINISH

A. Boxes shall be corrosion resistant.

B. Fronts shall be powder finish painted ANSI 61 gray.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that panelboards are ready to install.

B. Verify field measurements are as instructed by manufacturer.

C. Verify that required utilities are available, in proper location and ready for use.

D. Beginning of installation means installer accepts conditions.

3.2 INSTALLTION

A. Install per manufacturer's instructions.

B. Install required safety labels.

3.3 FIELD QUALITY CONTROLS

A. Inspect installed panelboards for anchoring, alignment, grounding and physical damage.

B. Check tightness of all accessible mechanical and electrical connections with calibrated torque wrench. Minimum acceptable values are specified in manufacturer's instructions.

C. Test each key interlock system for proper functioning.

3.4 ADJUSTING

A. Adjust all circuit breakers, access doors, operating handles for free mechanical and / or electrical operation as described in manufacturer's instructions.

3.5 CLEANING

A. Clean interiors of panels to remove construction debris, dirt, shipping materials.

B. Repaint scratched or marred exterior surfaces to match original finish.

END OF SECTION 26 24 16

SECTION 26 27 26 – WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Provide labor, material, equipment, related services, and supervision required, including, but not limited to installation, connections and testing of all wiring devices and accessories as required for the complete performance of the work, as shown on the Drawings, as specified herein.

B. RELATED SECTIONS

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

2. Division 26 Section "Common Work Results for Electrical".

1.2 REFRENCES

A. The equipment in this specification is designed and manufactured according to latest revision of the following standards (unless otherwise noted).

1. National Electrical Contractors Association (NECA):

2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)

3. National Electrical Manufacturers Association (NEMA) FB 11, WD 1, and WD 6

4. Underwriters Laboratories (UL) 498, 943

1.3 SUBMITTALS

A. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.

B. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.

C. Manufacturer shall provide copies of following documents to owner for review and evaluation in accordance with general requirements of Division 1 and Division 26.

1. Product data on specified product documenting the following

a. Data Jacks

b. Receptacles

c. Switches

D. Provide a guarantee against defective materials and workmanship in accordance with requirements of the Section 26 05 00 of these Specifications.

PART 2 - PRODUCTS

2.1 DATA AND TELEPHONE JACKS

A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Hubbel, Leviton, or Panduit.

B. Telephone and data jack UL 1863, compatible with Category 5, 5e, and 6a cable.

2.2 RECEPTACLES

A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Arrow Hart, Bryant, Hubbel, Leviton, Pass & Seymour, or Square D.

B. General purpose receptacles NEMA WD 1, Configuration 5-15R, 15 amps, 125 volts, unless otherwise indicated.

C. Corrosion resistant receptacles NEMA WD 1, UL 498, Nylon face, Configuration 5-20R, 20 amps, 125 volts, Industrial Extra Heavy Duty, unless otherwise indicated.

D. Ground fault circuit interrupter receptacles UL 943, NEMA WD 1, Configuration 5-15R, 15 amps, 125 volts, unless otherwise indicated.

2.3 SWITCHES

A. Subject to being equivalent and subject to compliance with requirements, provide product by one of the following manufacturers; Arrow Hart, Bryant, Hubbel, Leviton, or Pass & Seymour.

B. General purpose switches shall be NEMA WD 1, AC type, extra-heavy duty industrial grade, 15amp, 277Volt. Provide 3- or 4-way switches as shown on the Drawings.

C. Motor rated switches shall be UL 508, two or three-pole totally enclosed switch, 30amp, 600Volt.

D. Provide switches with occupancy sensor where shown on the Drawings.

2.4 COVER PLATES

A. Provide and install single and combination types to match corresponding wiring devices. Oversized plates shall be installed where standard-sized plates do not fully cover the wall opening.

B. Cover plates for recessed, wiring devices shall be stainless steel unless shown otherwise.

C. Cover plates, trim rings, etc. for recessed, floor-mounted electrical items shall match finish of building hardware (stainless steel, brass, etc.) in area installed.

D. Cover plates for exposed wiring devices shall be of same material as exposed outlet boxes

E. Weather proof cover plates shall be in-use type rated for use in wet locations per the NEC.

2.5 FINISHES

A. All wiring devices (switches, receptacles, etc.) shall be gray in color unless noted otherwise.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Conduit and wire for receptacle installation not shown on the Drawings shall be, sized, furnished and installed by Contractor. Conductors shall be minimum 12 AWG, and conduit shall be minimum ¾" for convenience outlet installation.

B. Install devices and assemblies level, plumb and square with building lines.

C. Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

D. Remove wall plates and protect devices and assemblies during painting.

E. It is the Contractor's responsibility to coordinate with all trades to secure correct wiring device installation locations. Adjust locations of floor service outlets and wiring devices to suit arrangement of partitions and furnishings.

F. Mounting Height

1. Approximate dimensions to the centerline of the device box are listed below. The exact locations and mounting heights shall be determined in the field, and it is the Contractor's responsibility to coordinate with all trades to secure correct installation. Where specified heights do not suit building construction or finish, adjust up or down to avoid interference. Do not straddle CMU block or other construction joints. Verify door swings with Architectural plans.

2. Install light Switches 48 inches above floor, when located next to door, install opening side of door.

3. Install general interior convenience receptacles 16 inches above floor. unless noted otherwise on the Drawings.

4. For countertop installations, install device plate bottom flush with top of backsplash, or 6 inches above counter tops without backsplash.

5. In garages, basements, shops, storerooms, and rooms where equipment may be hosed down and outdoors install wiring devices 48 inches above floor unless noted otherwise on the Drawings.

6. Install special-purpose receptacles 48 inches above floor unless noted otherwise on the Drawings.

3.2 IDENTIFICATION

A. Use tape labels for identification of individual wall switches and receptacles in dry indoor locations.

1. Use black letters on white background, unless noted otherwise.

2. Identify panelboard and circuit number from which item is served on face of plate.

3. Identify conductors with wire markers or tags inside outlet boxes.

END OF SECTION 26 27 26

SECTION 26 28 11 – MOLDED CASE CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for molded case circuit breakers (also identified as MCCB) as required for the complete performance of the work, as shown on the Drawings, as specified herein, and as specified elsewhere for the assemblies or systems comprised of the components specified herein.

B. RELATED SECTIONS

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

2. Division 26 Section "Common Work Results for Electrical".

3. Refer to the equipment specification sections in which the circuit breakers will be installed for additional requirements. This may include but not be limited to the following specifications sections:

   a. Enclosed Switches and Circuit Breakers

   b. Low Voltage Switchgear

   c. Switchboards

   d. Low Voltage Motor Control Centers

1.2 REFRENCES

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

1. Canadian Standards Association (CSA):

   a. C22.2 No.5, “Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures”

2. US Federal Specifications and Standards

   a. FED W-C-375E

3. International Electrotechnical Commission (IEC):

   a. IEC 60947-2, “Low-Voltage Switchgear and Controlgear - Part 2: Circuit-Breakers”

   b. IEC 60947-3, “Low-Voltage Switchgear and Controlgear - Part 3: Switches”

4. International Organization for Standardization (ISO):

   a. ISO 9001, “Quality Management Systems - Requirements”

5. Mexican ANCE Standards

   a. NMX-J-266-ANCE

6. National Electrical Manufacturers Association (NEMA)

   a. NEMA AB-1, “Low-voltage Circuit Breakers”

7. Underwriters Laboratories, Inc. (UL):

   a. UL 489, “Low-voltage AC and DC Circuit Breakers"

1.3 DEFINITIONS

A. Unless specifically defined within the Contract Documents, the words or acronyms contained within this specification shall be as defined within, or by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.

1. ICCB: Insulated Case Circuit Breaker

2. LVPCB: Low Voltage Power Circuit Breaker

3. MCCB: Molded Case Circuit Breaker

4. LSIG or combination of these letters: type of protection and available adjustments on certain trip units.

   a. L: Long Time (overload protection, analogous to the inverse-time thermal trip of a thermal/magnetic breaker)

   b. S: Short Time (short circuit protection of low level faults)

   c. I: Instantaneous (short current protection of high level faults, analogous to the instantaneous magnetic trip of a thermal/magnetic breaker)

   d. G: Ground Fault (equipment ground fault protection)

   e. Therefore, LSIG = Long-time + Short-time + Instantaneous + Equipment Ground-fault Protection

1.4 SUBMITTALS

A. Manufacturer shall provide copies of following documents to owner for review and evaluation in accordance with general requirements of Division 1 and Division 26:

B. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.

C. Product Data on specified product;

D. Shop Drawings on specified product;

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of ten years.

1. The manufacturer shall have a valid ISO 9001 certification and an applicable quality assurance system that is regularly reviewed and audited by a third party registrar. Manufacturing, inspection, and testing procedures shall be developed and controlled under the guidelines of the quality assurance system.

B. All work performed and all materials used shall be in accordance with the National Electrical Code, and with applicable local regulations and ordinances. Process controllers, assemblies, materials, and equipment shall be listed and labeled by Underwriter's Laboratories or by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prior to delivery to the Project site, ensure that suitable storage space is available to store materials in a well ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres. Materials shall be protected during delivery and storage and shall not exceed the manufacturer stated storage requirements.

B. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified within the Contract Documents.

C. Inspect and report any concealed damage or violation of delivery storage, and handling requirements to the Engineer.

1.7 WARRANTY

A. Additional Owner Rights: The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to and run

concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

PART 2 - PRODUCTS

A. GENERAL REQUIREMENTS

1. Basis-of-Design Product: Subject to compliance with requirements, provide PowerPact TM circuit breakers with thermal-magnetic or Micrologic electronic trip units by Schneider Electric or equal.

B. Acceptable Products: Circuit Breakers specified herein shall be the product of a single manufacturer. Products and manufacturers specified are to establish a standard of quality for design, function, materials, and appearance. Products shall be modified as necessary by the manufacturer for compliance with requirements. Provide the following specified product and manufacturer without exception, unless approved as a substitute by addendum to the Contract Documents prior to the bid date:

1. PowerPact Circuit Breakers by Schneider Electric

2. Or equal by ABB

3. Or equal by Eaton

2.2 CIRCUIT BREAKERS

A. Circuit breakers shall have voltage and interrupting ratings that meet the application requirements. Interrupting rating shall be available up to 200 kAIR without fuses. Circuit breakers shall be available in frame sizes as follows: B-frame (125A), H-frame (150A), J-frame (250A) Q-frame (225A) L-frame (600A), M-frame (800A), P-frame (1200A) and R-frame (3000A). There are also additional legacy frames FA/FH (100A) and LA/LH (400A) thermal-magnetic circuit breaker.

B. Circuit breakers shall be constructed using glass reinforced insulating material.

C. Current carrying components shall be completely isolated from the handle, and the accessory mounting area.

D. Circuit breakers shall have an overcenter, trip-free, toggle-operating mechanism which shall provide quick-make, quick-break contact action. The circuit breaker shall have common tripping of all poles.

E. From 125 A to 600 A rating frame, MCCBs breaking unit shall be made with a double rotary contact to limit let-through energy on the installation

F. MCCBs shall be designed to trip the circuit breaker in the event of high-level short-circuit currents. This design shall be independent of the thermal-magnetic or electronic trip unit.

G. The circuit breaker handle shall reside in a tripped position between ON and OFF to provide local trip indication. Circuit breaker escutcheon shall be clearly marked ON and OFF in addition to providing international I/O markings.

H. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on the face of the circuit breaker.

I. Each circuit breaker shall be equipped with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit breaker tripping mechanism for maintenance and testing purposes.

J. Circuit breakers shall be factory-sealed with a hologram quality mark or a tamper evident label and shall have a date code.

K. MCCB's shall be able to receive a device for locking in the isolated position.

L. Electronic components shall withstand temperatures up to 221 °F (105 °C).

M. Circuit breakers shall be UL-listed to accept field installable/removable mechanical type lugs (except Type QB/QD/QG/QJ). Lugs shall be UL-listed to accept solid and/or stranded copper and aluminum conductors.

N. Circuit breakers shall be capable of accepting bus connections.

O. For frame ratings, higher than 250 amperes, MCCBs shall be fitted with metallic filters to reduce effects perceptible from the outside during current interruption.

P. For a given MCCB rated frame, MCCBs dimensions shall be the same whatever the AIR.

Q. P-frame (1200 amperes frame) shall be available in manually operated version and electrically operated version.

R. The P-frame electrically operated version shall be of the stored-energy type only and will be equipped with anti-pumping function.

S. The P and R-frame circuit breakers shall be equipped with a safety interlock which keeps the circuit breaker open if the trip unit is not installed.

2.3 TRIP UNITS

A. MCCB's with frame ratings 150 to 400 amperes shall be equipped with electronic trip units. MCCB's with frame rating 125 amperes shall be equipped with thermal magnetic trip units.

B. MCCB's with ratings over 400 amperes shall be equipped with electronic trip units.

C. Circuit breakers with permanent trip units shall be UL-listed for reverse connection without restrictive line and load markings and be suitable for mounting in any position.

D. MCCBs with field interchangeable trip units shall have trip units that are easily interchangeable and easily secured to the MCCB.

E. The trip units shall not augment overall circuit breaker volume.

F. Thermal Magnetic (400 Ampere Frame and Below):

1. "PowerPact Q-, B-, H- and J-Frame", FA, FH, FY, LA, and LH as manufactured by Square D by Schneider Electric.

2. Thermal trip elements shall be factory preset and sealed. Circuit breakers shall be true RMS sensing and thermally responsive to protect circuit conductor(s) in a 104 °F (40 °C) ambient temperature.

3. Circuit breaker frame sizes 250 amperes and above shall have a single magnetic trip adjustment located on the front of the circuit breaker

4. Where indicated on drawings, circuit breakers shall be equipped with a ground fault module (GFM) with 20 to 200 amperes sensitivity level or earth leakage module (ELM) with sensitivity ranges between 30 mA and 3 amperes, or approved equivalent.

G. Electronic Trip Circuit Breakers. Trip units shall be Micrologic.

1. "PowerPact H-, J-, L-, P-, and R-Frame" (15 to 3000 amperes) as manufactured by Square D by Schneider Electric.

2. Micrologic electronic trip unit shall be true RMS sensing.

3. Air core current transformers shall be used to ensure accurate measurements from low currents up to high currents.

4. Electronic trip unit shall be fitted with thermal imaging to protect intermittent short circuits or ground-faults.

5. The following monitoring functions shall be integral parts of electronic trip units:

a. A test connector shall be installed for checks on electronic and tripping mechanism operation using an external device.

b. LED for load indication at 105 percent.

c. LED for load indication at 90 percent of load for applications 600 amperes and smaller

d. LED for visual verification of protection circuit functionality for applications 600 amperes or smaller.

e. Optional: LED for trip indication for applications above 600 amperes.

f. Micrologic trip unit functions shall consist of adjustable protection settings with the capability to be set and read locally by rotating a switch.

g. Long-time pickup shall allow for adjustment to nine long-time pickup settings. This adjustment must be at least from 0.4 to 1 times the sensor plug (In), with finer adjustments available for more precise settings to match the application.

h. Adjustable long-time delay shall be in nine bands. At six times lr, from 0.5 to 24 seconds above 600 amperes, and 0.5 to 16 seconds for 600 amperes and below.

i. Short-time pickup shall allow for nine settings from 1.5 to 10 times Ir.

j. Short-time delay shall be in nine bands from 0.1–0.4 I^2t ON and 0–0.4 I^2t OFF.

k. Instantaneous settings on the trip units with LSI protection shall be available in nine bands.

1) Above 600 amperes, from 2 to 15 times ln

2) 600 amperes, from 1.5 to 11 times ln

3) 400 amperes from 1.5 to 12 times ln

4) 250 amperes and below, from 1.5 to 15 times ln

l. Four-pole devices shall be equipped for neutral protection with a three-position setting; neutral not protected, neutral tripping threshold equal to half the phase value, and neutral threshold equal to the phase value.

m. Ground fault settings for circuit breaker sensor sizes 1200 amperes or below shall be in nine bands from 0.2 to 1.0 times In. The ground fault settings for circuit breakers above 1200 amperes shall be nine bands from 500 to 1200 amperes.

6. It shall be possible to fit the trip unit with a seal to prevent unauthorized access to the settings in accordance with NEC Section 240-6(b).

7. Trip unit shall provide local trip indication and capability to locally and remotely indicate reason for trip, i.e., overload, short circuit, or ground fault.

8. Neutral current transformers shall be available for four-wire systems.

9. Trip units shall have the capability to electronically adjust the settings locally and remotely to fine increments below the switch settings. Fine increments for pickup adjustments shall be 1 ampere. Fine increments for delay adjustments shall be one second

10. Trip units shall be available to provide real time metering. Metering functions shall include, but shall not be limited to, the following:

a. Current (phases, neutral, average, maximum)

b. Voltage (phase-to-phase, phase-to-neutral, average, unbalance)

c. Power (active [kW], reactive [kVAR], apparent [kVA], power factor)

d. Energy (active [kWh], reactive [kVAR], apparent [kVA])

e. Frequency

f. Total harmonic distortion (current, voltage)

g. Metering accuracy shall be 1.5 percent current (above 600 amperes), 1.0 percent current (600 amperes and below), 0.5 percent voltage, and 2 percent energy. This accuracy shall be total system, including, but not limited to, CT and meter.

11. Measurement chain shall be independent from the protection chain.

12. The measurements shall be displayed on the breaker itself and/or on a remote display and/or on a remote system via Modbus communication.

13. Connections from circuit breaker to remote display and/or communication module shall be plug-n-play via RJ45 connector. No special tools or programming shall be required.

H. Electronic Trip ET 1.0 Trip System (300 to 800 Amperes):

1. "PowerPact M-Frame" (300 to 800 amperes) as manufactured by Square D by Schneider Electric.

a. The circuit breaker trip system shall be a microprocessor-based true RMS sensing design.

b. Sensor ampere ratings shall be as indicated on the drawings or schedules.

c. The integral trip system shall be independent of any external power source and shall contain no less than industrial grade electronic components.

d. Trip unit shall not be field-replaced.

e. ET 1.0 trip unit functions shall consist of adjustable instantaneous pickup with no intentional time delay.

f. The long time trip point setting shall be fixed and cannot be adjusted.

g. The instantaneous settings on the trip unit shall allow 2 to 10 times the sensor rating (In).

h. The trip unit shall have the capability for the adjustment to be set and read locally by a rotating switch.

1) Ground fault protection shall not be provided.

2.4 ACCESSORIES:

A. Circuit breakers shall be equipped with UL-listed electrical accessories as noted on the drawings or schedules or they may be field-installable.

B. The addition of auxiliaries shall not increase the volume of the circuit breaker.

C. B-frame (125 amperes) circuit breakers shall have auxiliary location and function easily identifiable outside the face plate through viewing windows.

D. The addition of a motor mechanism module or a rotary handle, etc., shall not mask or block device settings.

E. Electrical Auxiliaries: Electrical auxiliaries such as voltage releases (shunt trip and undervoltage) and indication switches as follows:

1. Same field-installable auxiliary contacts for signaling different functions, such as open/ closed position, fault signal, electrical fault (including electrical leakage) signal. Auxiliaries shall be common for the entire H-, J-, L-, M-, P-, and R-frame range,

2. Electrical auxiliaries shall be separated from power circuits,

a. Electrical auxiliaries shall be of the snap-in type and fitted with terminal blocks,

b. Electrical auxiliary function and terminals shall be permanently engraved on the case of the circuit breaker and the auxiliary itself.

3. P and R-frame circuit breakers shall have coils designed for continuous duty.

F. Equipment Ground Fault Protection Modules (Thermal Magnetic Circuit Breakers):

1. “PowerPact H- and J-Frame” as manufactured by Square D by Schneider Electric.

a. Circuit breakers shall be equipped with a ground fault module (GFM) with 20 to 200 amperes sensitivity level or earth leakage module (ELM) with sensitivity ranges between 30 mA and 3 amperes, or approved equivalent.

b. Ground fault sensing system shall be modified zero sequence (GFM) or zero sequence (ELM) sensing type.

c. The ground fault system shall require no external power to trip the circuit breaker.

d. Companion circuit breaker shall be equipped with a ground fault shunt trip.

e. The ground fault sensing system shall be suitable for use on solidly grounded systems.

f. The ground fault sensing system shall be suitable for use on three-phase, three-wire circuits where the system neutral is grounded but not carried through the system or on three-phase, four-wire systems. ELM shall be suitable for use on three-phase, three-wire circuits only.

g. Ground fault pickup current setting and time delay shall be field adjustable. A switch shall be provided for setting ground fault pickup point. A means to seal the pickup and delay adjustments shall be provided.

h. The ground fault sensing system shall include, but shall not be limited to, a ground fault memory circuit to sum the time increments of intermittent arcing ground faults above the pickup point.

i. A means of testing the ground fault system to meet the on-site testing requirements of NEC Section 230-95(c) shall be provided.

j. Local visual ground fault trip indication shall be provided.

k. The ground fault sensing system shall be provided with zone selective interlocking (ZSI) communication capabilities compatible with other thermal magnetic circuit breakers equipped with ground fault sensing, electronic trip circuit breakers with integral ground fault sensing and external ground fault sensing systems as noted on the Drawings or schedules. ELM shall not be provided with ZSI capabilities.

l. The companion circuit breaker shall be capable of being group mounted.

m. The ground fault sensing system shall not affect interrupting rating of the companion circuit breaker.

G. Motor Operating Mechanism:

1. It shall be possible to equip H-, J-, L-, and P-frame circuit breakers with a motor mechanism for electrical operation. An auto/manual switch in front shall, when set to the manual position, lock out electrical control; when set to auto, lock out the manual control. Remote indication of manual or auto mode shall be possible. It shall also be possible to seal the access to the auto control. Closing shall take place in less than 5 cycles (80 ms).

2. Following tripping due to electrical faults (overload, short circuit, earth fault), remote reset shall be inhibited. It shall however be possible if opening was initiated by a voltage release.

3. The operating mechanism shall be of the stored energy type only.

4. The addition of a motor mechanism or a rotary handle shall in no way affect circuit breaker characteristics.

5. Only three stable tripping mechanism positions (ON, OFF, and tripped) shall be possible with the motor mechanism.

6. Suitability for isolation shall be provided by positive contact indication (ON and OFF) in front of the motor mechanism module.

H. Handle Accessories:

1. Circuit breaker handle accessories shall provide provisions for locking handle in the ON and OFF position.

2. Circuit breakers through 1200 amperes shall have available rotary handle operators and 15 through 600 amperes shall have an open door shaft operating tool.

3. Circuit breakers through 125 amperes shall have an available side mounted (lateral) rotary handle operator.

I. Connection Accessories

1. Circuit breakers rated 15 – 600 amperes shall have mechanical lugs that can be installed without the use of any tools

2. Circuit breakers rated 15 – 1200 amperes shall have I-LINE connections available for high density group mounted applications

3. Circuit breakers rated 15 – 125 amperes shall be DIN-Rail mountable without any extra components or accessories

4. Circuit breakers rated 15 – 125 amperes shall have creep-compensating terminations that maintain clamping forces over time without retightening

5. Circuit breakers rated 15 – 125 amperes shall be UL listed to accept fine stranded wire

6. Circuit breakers shall have available voltage tap connections that are separate from the power connection

7. Circuit breakers through 1200 amperes shall have available PDC lugs and long terminal shields – for UL508 applications

2.5 COMMUNICATING CIRCUIT BREAKER INTERFACE TO MONITOR, CONTROL, AND MAINTAIN ELECTRICAL EQUIPMENT

A. General

1. The circuit breaker shall be equipped with a communicating interface that makes it possible to monitor and control protection units with information on their status, to deliver maintenance and equipment information using an open protocol such as Modbus TCP/IP or Modbus RS485 serial line:

   a. Energy cost management: energy saving and optimization

   b. Electrical distribution network management: protection, monitoring & control

   c. Asset management: use optimization, predictive maintenance, equipment alarming

   d. Transmit data to the BMS or FTP Server

2. Communicating circuit breaker interface shall offer Ethernet TCP/IP 10/100 Mbps ports to be connected on the building Local Area Network (LAN) and shall offer a real time access to device data by using a standard internet web browser.

B. Characteristics, operating principle and indications

1. The following information shall be accessible for circuit breakers at all the layers of electrical distribution architecture (modular feeders up to incomer circuit breakers)

   a. ON/OFF position (O/F) / trip indication (SD) / fault-trip indication (SDE)

   b. Cradle management: Draw out position

2. The following commands shall be possible:

   a. open / close / reset

3. When advanced trip units are used, the following information shall be accessible:

    a. Instantaneous and demand values, maximum and minimum values, energy metering, demand current and power, power quality

    b. Protection and alarm settings

    c. Time-stamped trip and alarm histories and event tables

    d. Maintenance indicators

C. Communicating Circuit Breaker Interfaces functions:

1. Energy management system shall offer main interface and secondary interfaces for energy management issue. Data shall be collected via Ethernet TCP/IP and ModBus networks by which communicating circuit breakers, I/O digital and analog input modules, pulse counter, power meter and energy meter will be connected to interface.

2. A switchboard display shall be connected via Ethernet TCP/IP network to the switchboard interface and shall offer a real time direct data access to monitor and control devices and load.

3. Ethernet communication interfaces will be compliant to Device Profile Web Service (DPWS) for discovery on the local area network (LAN).

4. Energy management interface shall offer direct access to data collection to monitor and control devices and load.

5. Energy management interface shall collect:

    a. Data from communicating circuit breaker with embedded measurement capability

    b. Pulse from metering pulse electrical, gas, water counters

    c. Data from communicating energy meters or power meters

    d. Logic state of technical devices or equipment

    e. Device alarms with time logs

    f. Temperature analog sensor value

6. Energy management interface shall display via web pages:

    a. Energy consumption

    b. Electrical data network monitoring

    c. Alarms and events

    d. Energy quality monitoring

e. Equipment or devices status (open, close, tripped, NA) and indication of fault types (LT, ST, instantaneous, ground fault) faulty phases, interrupted current

f. Operation and predictive maintenance monitoring

7. Energy management interface shall integrate simple control functions via web pages:

a. Load and devices via digital output

b. Orders of actuator

D. Communicating Circuit Breaker Interface features

1. The main interface enables an intelligent modular unit (IMU), for air or molded case circuit breakers to be connected to an Ethernet network and enables gateway to Modbus serial line connection.

2. An intelligent modular unit is a mechanical and electrical assembly containing one or more products to perform a function in a switchboard (incoming protection, motor command, and control). The modular units are easily installed in the switchboard.

3. The features of the main interface are:

a. Dual Ethernet port for simple daisy chain connection

b. Device Profile Web Service (DPWS) for discovery on the local area network (LAN)

c. Dual Universal Logic Plug (ULP) compliant for advanced connection with Air or Molded Case circuit breaker

d. Gateway for Modbus-SL connected devices

e. Embedded set-up web pages

f. Embedded monitoring web pages

g. Embedded control web pages

h. Built-in email alarm notification

i. The interface mounts on a DIN rail

j. A stacking accessory enables the user to connect several Modbus interface for air or molded case circuit breaker without additional wiring.

k. The interface must be always supplied with 24 Vdc using an UL listed and recognized limited voltage/limited current or a class 2 power supply with 3 A maximum.

l. The interface provides DC supply to the Modbus interfaces for Air or Molded Case circuit breaker and it is not necessary to supply them separately.

m. The interface indicates the status of the interface, the Ethernet communication dual color ports, ULP and Modbus connections by using LED on the front panel.

n. A locking pad on the front panel of the interface enables or disables to send the remote control commands over the Ethernet network to the interface, and to the other modules of the connected IMU.

o. Pre-defined applications add new functions to the IMU in a simple way:

1) selection by the application rotary switch on the I/O application module, defining the application with pre-defined input/output assignment and wiring diagram

2) no additional setting with the customer engineering tool required. The resources not assigned to the pre-defined application are free for additional user-defined applications: cradle management, breaker operation, cradle management and Energy Reduction Maintenance Setting (ERMS), light and load control and other custom for protection / control / energy management / monitoring.

p. The firmware can be updated using FTP connection or customer engineering tool.

E. Switchboard display

1. Energy management system shall integrate a switchboard display. Switchboard display will be connected to switchboard interface via Ethernet TCP/IP network to offer:

a. Real time display monitoring of devices

b. Simple control of devices and load.

c. Switchboard display shall integrate functions to monitor:

1) Energy consumption

2) Electrical network data

3) Alarms and events

4) Energy quality

5) Equipment or devices status (open, close, tripped, NA) and indication of fault types (LT, ST, instantaneous, ground fault) faulty phases, interrupted current.

6) Predictive maintenance monitoring contact wear rate, load profile, and the circuit breaker counter values

F. Operating and installation principles

1. Positioning, installation and connection of communicating interface

a. When the application requires the usage of several communicating interfaces:

1) The interface enabling communication with the monitoring system (outside the switchboard) could be using a Modbus TCP/IP

2) The other device interfaces inside the switchboard shall be using Modbus RS485 SL

3) The different device interface shall be interconnected by Modbus RS485 SL daisy chaining, inside the switchboard, using stackable connectors

4) The device interfaces shall be positioned on DIN rail for quick viewing of the network set up and status

5) The communicating interface shall be equipped with plug-in type input/output application module

6) The interfaces / devices links shall preferably be of the prefabricated type with RJ45 connectors that allow the device to be connected to the interface in a single operation and with no risk of error

2. Operation of the communicating interface

a. The communicating interface shall be capable of being easily integrated into the installation's communication network with automatic adaptation of their communication parameters to match those of the network

b. They shall provide data to the supervisor in Modbus tables, at fixed addresses that require no configuration

c. The data shall be of the type described in chapter 3.2

d. The concentrators shall be capable of receiving from the supervisor, by writing in the Modbus table at fixed addresses

e. They shall be capable of having the orders executed by the control devices, after having taken into account the devices' current positions

f. The communicating interface should be able to monitor and control auxiliaries and devices using integrated web page

g. The communicating interface should be able to monitor analog temperature sensors

3. Testing of the system in the switchboard

a. The manufacturer shall supply a (software) tool for overall testing of the system, within the limits of the switchboard: the entire data transmission and control chain between the modular devices and all of the concentrators, including communication.

b. The test tool shall supply a report that includes the list of all the devices connected to each channel of the data concentrators as well as a diagram describing the configuration of the system with indication of the associated Modbus addresses.

4. Operation and maintenance

a. Product measurement and communication capability shall offer operating assistance function:

1) Status of circuit breaker operations: Open/Close/Tripped/NA

2) Indication of fault types (LT, ST, instantaneous, ground fault) faulty phases, interrupted current

3) Trips history

4) Alarms history

5) Events history (setting changes, test…)

6) These functions and indicators shall be available by remote display, communication or Engineering tool

b. The main interface web pages and switchboard display allow the authorized group to:

1) Execute one or more reset commands per device type

2) Control the following applications remotely:

a) Circuit breaker operations: Open/Close

b) Reset input counters, reset output counters, light control, load control, user-defined output control

3) To provide maintenance log information:

a) The date and time the entry was made and the name of the user who made it.

b) The maintenance counter information for the selected device: circuit breaker operation counters, trip and alarm counters, load profile, contact wear counters, and the cradle counters.

4) To send and display alarms:

a) User shall be able to activate alarms based on measurement (I, V, F, P, Q, S, THD, CosPhi, FP, Idemand, Pdemand,) or counters

b) Alarms shall be time stamped

c) Alarms could activate a digital output for local indication

d) These functions and indicators shall be available by remote display, communication or Engineering tool.

PART 3 - EXECUTION

A. GENERAL

B. In addition to the requirements specified herein, execution shall be in accordance with the requirements of Specification Division 26 and Drawings.

END OF SECTION 26 28 11

SECTION 26 28 16 – SAFETY SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, configuration and installation for low voltage safety switches as required for the complete performance of the work, as shown on the drawings, as specified herein.

B. RELATED SECTIONS

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

2. Division 26 Section "Common Work Results for Electrical".

1.2 REFRENCES

A. As applicable to the specifics of the project drawings and the specifics of the application for this project, the low voltage safety switches, shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted on the project drawings or annotated in any sections below).

1. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)

2. NEMA KS 1, Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum)

3. UL 98, Enclosed and Dead Front Switches

1.3 DEFINITIONS

A. General Duty. Designed for residential and light commercial where duty is not severe. Rated 240Vac or 250Vdc maximum.

B. Heavy Duty. Designed for applications where safety, high performance and continuity of service is required. Rated at 600Vac or 600Vdc maximum.

C. Mill Duty. Designed for mill, foundry and industrial applications where safety, high performance and continuity of service is required. Rated at 600Vac or 600Vdc maximum.

D. Double Throw. Designed for applications where the ability to switch between either (2) sources or (2) loads is required. Rated 600 Vac or 250Vdc maximum.

E. Standby Power Transfer. Designed for applications to permit the connection of power from a standby generator or other source of electricity and are ideally suited for outdoor applications in rural dwellings and farm buildings. Rated 120/240Vac or 240V maximum.

F. NEMA 1 Enclosures. Indoor use to provide a degree of protection to personnel against access to hazardous parts and to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt).

G. NEMA 3R Enclosures. Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow); and that will be undamaged by the external formation of ice on the enclosure.

H. NEMA 4 Enclosures. Indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); that provides an additional level of protection against corrosion; and that will be undamaged by the external formation of ice on the enclosure.

I. NEMA 4X Enclosures. Indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); that provides an additional level of protection against corrosion; and that will be undamaged by the external formation of ice on the enclosure.

J. NEMA Type 5 Enclosures. Indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and settling airborne dust, lint, fibers, and flyings);and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing, hose directed water and the entry of water during occasional temporary submersion at a limited depth) and that will be undamaged by the external formation of ice on the enclosure.

K. NEMA Type 12 Enclosures. Constructed for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and circulating dust, lint, fibers, and flyings); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing).

L. UL Listed and cUL Listed. Products that have been tested by Underwriters Laboratories and have met the construction and performance requirements of the applicable UL standards number.

1.4 SUBMITTALS

A. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.

B. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.

C. The contractor/installer shall provide electronic copies of the following documents in PDF format as APPROVAL drawings to the engineer/owner for review and evaluation. It is preferred that the drawing format be provided in letter/size "A" (8.5" x 11") or tabloid/size "B" (11" x 17") format to facilitate easy copying. Manufacturing of the equipment will not begin until the submitted documents are stamped/noted "approved" or "approved as noted" by the engineer/owner and officially released for manufacturer by the contractor/installer/distributor/owner.

D. APPROVAL documents for the specified product shall include:

1. Safety Switch Information Drawing – by the equipment manufacturer. This "by each type" document shall contain at least the following information for each type of safety switch on the project. For exactly identical types, quantities of the safety switches shall also be indicated.

    a. Overall enclosure dimensions

    b. Number of switching poles

    c. Current rating

    d. Voltage rating

    e. Knockout dimensions

    f. Horsepower rating (if applicable)

    g. Neutral connection / block (if applicable)

    h. Ground connection / block

2. Safety Switch Brochure – detailing the general construction of the product – by the equipment manufacturer

E. The contractor/installer shall provide electronic copies of the following documents in PDF format to reflect the AS BUILT condition of the equipment to the engineer/owner for their record documentation. It is preferred that the drawing format be provided in letter/size "A" (8.5" x 11") or tabloid/size "B" (11" x 17") format to facilitate easy copying. 'D. AS BUILT documents for the specified product shall include:

1. Safety Switch Information Drawing – by the equipment manufacturer. This "by each type" document shall contain at least the following information for each type of safety switch on the project. For exactly identical types, quantities of the safety switches shall also be indicated.

    a. Overall enclosure dimensions

    b. Number of switching poles

    c. Current rating

    d. Voltage rating

    e. Knockout dimensions

    f. Horsepower rating (if applicable)

    g. Neutral connection / block (if applicable)

    h. Ground connection / block

1.5 QUALITY ASSURANCE

A. The manufacturer shall have specialized in the manufacture of low voltage safety switches for at least 15 years.

B. The low voltage safety switches shall be listed and/or classified by Underwriters Laboratories in accordance with standards listed in the "REFERENCES" section of this specification above.

C. Equipment shall be qualified for use in for any site with a site specific SDS equal or less than the values below and at any location within a building as follows:

1. High seismic loading as defined in IEEE Std 693-2005, with 1.33 amplification factor.

2. IBC-2015, Ip = 1.5, for z/h equal to in accordance with ICC-ES-AC156.

    a. NEMA 1/3R/5/12, 30A – 100A: Sds = 2.71 g

    b. NEMA 1/3R/5/12, 200A – 600A: Sds = 1.59 g

    c. NEMA 1/3R/5/12, 800A – 1200A: Sds = 1.21 g

    d. NEMA 4/4X, 30A – 600A: Sds = 1.22 g

3. The safety switches shall be seismic certified as documented in OSP-0320-10.

4. Seismic compliance shall be qualified only through shake table testing.

1.6 DELIVERY, STORAGE, AND HANDLING

A. The manufacturer shall ship each safety switch in an individual carton for ease of handling.

B. The contractor/installer shall inspect and if necessary, report any concealed damage to carrier within 48 hours of the safety switches being delivered. The contractor/installer shall be responsible for all claims with the shipper.

C. The contractor/installer shall store the safety switches in a clean, dry space and shall maintain factory protection and/or cover the products with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic.

D. The contractor/installer shall handle the safety switches in accordance with all appropriate NEMA instructions to avoid damaging them.

1.7 PROJECT CONDITIONS (SITE ENVIRONMENTAL CONDITIONS)

A. The contractor/installer shall follow all appropriate standards and service conditions before, during and after the safety switch installation.

B. The safety switches shall be located in well ventilated areas, free from excess humidity, dust and dirt and away from hazardous materials.

C. Indoor locations shall be protected to prevent moisture from entering enclosure.

1.8 WARRANTY

A. Manufacturer warrants equipment to be free from defects in materials and workmanship for 1 year from date of installation or 18 months from date of purchase, whichever occurs first.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. GE by ABB products have been used as the basis for design. Other manufacturers' products of equivalent quality, dimensions and operating features may be acceptable, at the Engineer's discretion, if they comply with all requirements specified or indicated in these Contract documents. The following equipment shall be provided:

1. ABB

2. Square D

3. Eaton

2.2 PRODUCT INFORMATION

A. Refer to the project drawings and the safety switch schedules for the locations and quantities. The drawings and schedules shall also include information about the current and voltage ratings of devices.

B. Product Requirements

1. An extra-large, legible ON/OFF label shall be provided on the front door cover of the switch for switch on – off position indication.

2. The box mounted operation handle shall be a highly visible bright red color to provide easy identification of the switch position and shall directly drive the switch mechanism.

3. The switch operation handle shall be capable of being padlocked in the OFF position with up to three padlocks with 5/16 inch diameter shanks. The handle on Heavy Duty or Mill Duty switches shall have a “donut” configuration to allow operation by a hook stick.

4. All movable contacts shall be silver plated. Heavy Duty switches, 30A through 200A, 600V or 600Vdc, shall have clear line shields to allow visual confirmation of plated blade position while helping to protect against accidental contact with live parts.

5. A wide wiring gutter, clear of obstructions and moving parts shall be provided. The interior shall be easily removable and contain line and load copper/aluminum lugs suitable for use with 60 degree C and 75 degree C conductors.

6. The switch shall be suitable for use as service entrance equipment when installed in accordance with National Electrical Code unless otherwise specified.

7. The enclosure finish shall consist of degreasing, phosphate cleaning, and an electro-deposit of the manufacturer’s standard gray enamel paint.

8. Heavy Duty switches shall have defeatable, front access, coin-proof interlocks. These interlocks shall prevent opening the switch door when switch is ON and prevent turning the switch ON when door is open. The interlocks must, however, allow entrance into the enclosure when the switch is OFF without the use of tools for “Contact Open” inspection.

9. General Duty switches up through 200A shall have interlocks that prevent opening the switch door when switch is ON.

10. Double-throw switches shall have interlocks to prevent opening the switch door when switch is ON and prevent turning the switch ON when door is open. However, the interlocks must allow entrance into the enclosure when the switch is OFF without the use of tools for “Contact Open” inspection.

11. Should class J fuses be required on the project, the contractor/installer shall relocate the load side fuse block holder of Heavy Duty or Double Throw switches from the standard “Class H/R Fuse Location” to the “Class J Fuse Location”.

12. Some fuses require kits. Reference the rating label of the switch or publication DET-845 for specific kit numbers

C. Voltage Rating. Refer to the project drawings and safety switch schedules for the appropriate voltage rating of each switch.

D. Continuous Current Rating. Refer to the project drawings and safety switch schedules for the required ampere ratings of each switch.

E. Short Circuit Current Rating

1. Refer to the project drawings and safety switch schedules for the required short circuit rating.

2. Fusible safety switches shall have a minimum short circuit rating per the table listed below. This rating shall be equal to or greater than the short-circuit available from all sources. The contractor/installer shall provide and install the appropriate fuses to achieve the required AIC rating. The switches shall also contain a label showing the appropriate short circuit value at the rated voltage with the proper fuses installed.

Minimum Fusible Safety Switch Withstand Current Ratings			
Switch Type	**Max. System Voltage**	**Fuse Class**	**Withstand Rating (Symmetrical Amps)**
General Duty	250 Vac / 250 Vdc	K	10,000
		H	10,000
		R	100,000
Heavy Duty	600 Vac / 250 Vdc	H	10,000
		R	200,000
		J	200,000
		L	100,000
Double Throw	600 Vac / 250 Vdc	R	100,000
		J	100,000
		T	100,000
		L	100,000

3. Non-fusible safety switches shall have a minimum withstand rating of 10,000A symmetrical. Fusible switch withstand ratings shall apply to non-fused switches when protected by an upstream fuse as listed. Higher withstand ratings allowed by protection

of upstream molded case circuit breakers is acceptable when these ratings are documented in manufacturer's UL series combination rating literature, DET-008, or the UL certification directory.

F. Enclosures

1. NEMA 12 enclosures, when furnished, shall be provided without knockouts.

2. NEMA 4/4X enclosures shall be fabricated using 304 stainless steel

2.3 ACCESSORIES

A. Provide the following accessories where indicated on drawings.

1. Neutral Kit

2. Equipment Ground Kit

3. Auxiliary contacts. Auxiliary contacts shall be designed to open before switch blade contacts part.

4. Fuse Kit Only (no fuses)

5. Fuses and Fuse Kit

6. Crouse Hinds receptacle, interlocked with switch and mating Arctite #APJ48S plug.

7. Copper Line and Load Lugs

PART 3 - EXECUTION

3.1 GENERAL

A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of Specification Division 26 and Drawings.

3.2 EXAMINATION

A. Examine equipment exterior and interior prior to installation. Report any damage and do not install any equipment that is structurally, moisture, or mildew damaged.

B. The contractor/installer shall make all necessary field measurements to verify that the safety switches shall fit in the allocated space in full compliance with the minimum required clearances recommended by the manufacturer, specified in National Electrical Code and/or Canadian Standards Association required by any applicable local/facility constraints. The following examinations shall include but not be limited to the following.

1. Verify that the field measurements of the switches are the same as shown on factory drawings.

2. Inspect the safety switches and confirm that they are ready to be installed.

3. Check walls or the mounting structure for uniformity and a level plumb surface.

4. Examine the installation area to assure there is enough clearance to install the safety switches such that it will fit in the allocated space in full compliance with the minimum required clearances recommended by the manufacturer, specified in National Electrical Code and required by any applicable local/facility constraints.

5. Confirm that required utilities are available, in proper location and ready for use.

C. Commencement of installation means that the contractor/installer accepts these conditions.

3.3 LOCATION

A. Refer to the projects site layout drawings for details regarding the proper area to place the safety switches.

3.4 INSTALLATION

A. The contractor/installer shall furnish and completely install the low voltage safety switches as shown on the project drawings. All necessary hardware to secure the switches in place shall be provided by the contractor/installer.

B. The contractor/installer shall provide and install any required safety labels and identification labels.

C. The contractor/installer shall mount the safety switch in full compliance with NEC 404.8(A). The center handle shall not be more than 6’7” above the floor or working platform. The contractor/installer shall also verify any minimum ground clearance that is required.

D. The contractor/installer shall be responsible for procuring and installing any required fuses for fusible safety switches according to the manufacturer’s instructions.

3.5 FIELD QUALITY CONTROL

A. The following quality control checks shall be performed by the contractor/installer.

1. Inspect the installed safety switches for proper anchoring, alignment and grounding as well as inspecting for any internal and external physical damage.

2. Confirm that all shipping and packing material has been removed.

3. Check the tightness of all accessible mechanical and electrical connections with a calibrated torque wrench. The minimum acceptable values are specified in the manufacturer's instructions.

4. Check each electrical connection for proper phasing and identification.

5. With power off, check each switch for proper mechanical operation, preferable with the door open (using the interlock defeat to operate the switch), and confirm the continuity of each pole by visual movement of the blade and continuity tester. Confirm the continuity of all installed fuses.

6. With the door closed confirm the door will not open with the switch is in the ON position.

3.6 CLEANING

A. The contractor/installer shall clean the interior and exterior of the safety switches to remove construction debris, dirt, and shipping materials.

B. The contractor/installer shall perform minor touch-up on scratched or marred exterior surfaces to match original finish using an approved paint.

END OF SECTION 26 28 16

SECTION 26 29 23 – VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SUMMARY

A. This specification provides the requirements for an adjustable frequency drive, herein referred to as drive, factory integrated with branch circuit protection, power circuit components, control components and door mounted operator devices into an enclosure, herein referred to as drive panel, for variable torque fan and pump applications or for constant torque or fan and pump applications.

B. RELATED SECTIONS

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

2. Division 26 Section "Common Work Results for Electrical".

1.2 REFRENCES

A. The equipment in this specification is designed and manufactured according to latest revision of the following standards (unless otherwise noted).

1. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)

2. UL 50E – Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions

3. UL 508 – Industrial Control Equipment; Current Edition, Including All Revisions

4. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

5. NEMA – Application Guide For AC Adjustable Speed Drive Systems

6. NEMA ICS 7.1 – Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems

7. UL 61800-5-1 – Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements – Electrical, Thermal, and Energy (Ed. 2); Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate work to provide VFDs suitable for use with driven equipment.

B. Preinstallation Meeting: Review material selections and installation procedures with manufacturer's representative and affected installers.

1.4 SUBMITTALS

A. Provide sufficient information to determine compliance with Contract Documents. Identify submittal data with specific equipment tags and/or service descriptions to which they pertain. Identify specific model numbers, options, and features of equipment proposed.

B. Indicate deviations from Contract Documents with reference to corresponding drawing or specification number and written justification for deviation.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for variable frequency drives, enclosures, components, and accessories.

1. Indicate rated input kVA and output kVA or HP, topology, converter/inverter type, percent efficiency, and operating/electrical characteristics.

2. Include maximum Btu (kJ) heat release data and ambient cooling requirements.

D. Shop Drawings: Indicate enclosure dimensions, shipping section dimensions, weights, foundation requirements, required clearances, location and size of each field connection, and mounting and installation instructions.

E. Include project-specific elementary and interconnection diagrams for power, signal, control, and communications wiring that provide minimum detail shown for drawings in NFPA 79 appendix.

F. Operation and Maintenance Data:

1. Provide detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

a. Include manufacturer, supplier, support, and repair center contact information.

b. Include manufacturer’s standard operation and maintenance data assembled for each size and type of equipment furnished.

c. Include contact information for parts stocking location closest to Owner.

d. Include list of furnished and recommended spare parts.

e. Identify critical spare parts associated with long lead times and/or those critical to unit operation.

f. Identify maintenance spare parts required to regularly perform scheduled equipment maintenance including, but not limited to, consumable parts required to be exchanged during scheduled maintenance periods.

1.5 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70.
2. Requirements of authorities having jurisdiction.
3. Applicable local codes.

B. Manufacturer Qualifications:

1. Firm engaged in manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for minimum of 10 years.
2. Certified in accordance with ISO 9001 with applicable quality assurance system regularly reviewed and audited by third-party registrar. Develop and control manufacturing, inspection, and testing procedures under guidelines of quality assurance system.
3. Service, repair, and technical support services available 24 hours per day, 7 days per week from manufacturer or their representative.
4. Certified in accordance with ISO 14001.

C. Installer Qualifications: Firm with minimum 10 years experience with motor controllers of similar type and scope.

D. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prior to delivery to project site, verify suitable storage space is available to store materials in well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres.

B. Protect materials during delivery and storage and maintain within manufacturer's written storage requirements. At minimum, store indoors in clean, dry space with uniform temperature to prevent condensation and protect electronics from potential damage from electrical and magnetic energy.

C. Deliver materials to project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified in Contract Documents.

D. Inspect products and report concealed damage or violation of delivery, storage, and handling requirements to Owner.

1.7 WARRANTY

A. Manufacturer Warranty: Provide manufacturer warranty for defects in material and workmanship for 12 months from date of commissioning or 18 months from date of shipment, whichever comes first. Complete forms in Owner's name and register with manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Schneider Electric (Square D) products have been used as the basis for design. Other manufacturers' products of equivalent quality, dimensions and operating features may be acceptable, at the Engineer's discretion, if they comply with all requirements specified or indicated in these Contract documents. The following equipment shall be provided:

1. Schneider Electric, Altivar Process ATV600 or Equal
2. ABB
3. Or approved Equal

2.2 VARIABLE FREQUENCY MOTOR CONTROLLERS

A. Basis of Design: Schneider Electric; Altivar Process ATV600; www.se.com/#sle.

B. Standard Drive Units:

1. Altivar Process ATV630 or equal
2. Noncombination drive controller capable of feeding 3-phase synchronous and asynchronous motors.
3. Design for fluid management processing and energy saving with extensive flexibility for water/wastewater, mining, minerals/metals, oil/gas, and food/beverage applications.
4. Design for wall and/or cabinet mounting.
5. Available in range of tested combinations for protection and short circuit interrupt ratings.

2.3 Compact Drive Systems

A. Altivar Process ATV660 or equal.

B. Combination enclosed drive controller with integrated enclosures for wall or floor mounting depending on size.

C. Provide circuit breaker disconnect and adequate room for power peripherals, including isolation and bypass contactors, within same enclosure.

D. Available with full range of standard and engineered options for various application requirements.

2.4 Low Harmonic Drive Systems With Active Front End

A. Altivar Process ATV680 or equal:

B. Enclosed drive controller with integrated enclosures for floor mounting.

C. Provide circuit breaker disconnect with available cabinet additions for power peripherals, including standard and solid state bypass options.

D. Available with multiple standard and engineered options for various application requirements.

2.5 Description: Digitally controlled drive using pulse width modulation (PWM) for starting and speed control of standard IEC or NEMA MG 1 design, AC inverter-duty asynchronous motors and synchronous motors with permanent magnets by adjustment of output voltage and frequency.

2.6 Unless otherwise indicated, match VFD to load (variable or constant torque) and actual motor being controlled considering speed, current, kVA, and inrush requirements.

2.7 GENERAL REQUIREMENTS:

A. List and label as complying with UL 508 or UL 61800-5-1.

B. Comply with:

1. IEC 60068-2-78.
2. IEC 60146-1-1.
3. IEC 60664-1.
4. IEC 60447.
5. IEC 61439-1.
6. IEC 60364-1.
7. IEC 60204-1.
8. IEC 60529.

9. IEC 61000 (SERIES).
10. IEC 61800 (SERIES).
11. IEC 60721-3-3.
12. IEC 60255-149.
13. IEC 61000-4-2.
14. NEMA ICS 4.
15. NEMA ICS 7.

C. Environmental Requirements:

1. Rated to withstand the following environmental conditions while providing 100 percent output current continuously:
    a. Storage Temperature: From minus 40 degrees F (minus 40 degrees C) to 158 degrees F (70 degrees C).
    b. Operating Temperature:
        1) UL 50E Type 1: From 5 degrees F (minus 15 degrees C) to 122 degrees F (50 degrees C) without derating, up to 140 degrees F (60 degrees C) with derating of power stage.
        2) Enclosed: From 14 degrees F (minus 10 degrees C) to 104 degrees F (40 degrees C) without derating, down to 14 degrees F (minus 10 degrees C) with enclosure heater, up to 131 degrees F (55 degrees C) with derating of power stage.
    c. Relative Humidity: Between 0 and 95 percent without condensation in accordance with IEC 60068-2-78.
    d. Operating Altitude: Up to 3,280 feet (1000 m) without derating, up to 15,748 feet (4800 m) with derating.
    e. Corrosion Protection Level: IEC 60721-3-3, Class 3C3 for cooling air and chemical gases.
    f. Biological Protection Level: IEC 60721-3-3, Class 3B1.
    g. Dust Protection Level: IEC 60721-3-3, Class 3S3.
    h. Vibration and Shock Protection Level: IEC 60721-3-3, Class 3M3.
2. Derating: Provide derating factor as required in accordance with environmental conditions to prevent degradation of unit lifetime, performance, overload capability, or reliability.
3. Enclosure:
    a. Integral Enclosure: UL 50E Type 1, unless otherwise indicated on the Drawings.
    b. User Interface Terminal: UL 50E Type 12, mounted on front face of enclosure, and accessible for programming and controls with main door closed.
    c. Provide front-accessible cabinet constructed in accordance with IEC 60439-1.
    d. Provide bottom conduit entry to allow for top mounted cooling components.

e. Provide forced-air and heat-sink cooling system that does not require liquid or air condition cooling components for ambient temperatures within drive's stated ambient temperature operating range.

2.8 PERFORMANCE REQUIREMENTS

A. Provide normal duty rating unless otherwise indicated.

B. Normal Duty:

1. Overload Capability: Allow 110 percent current overload for one minute.
2. Overtorque Capability: Allow 110 percent of rated motor torque during 60 seconds, every 10 minutes.

C. Heavy Duty:

1. Overload Capability: Allow 150 percent current overload for one minute.
2. Overtorque Capability: Allow 150 percent of rated motor torque during 60 seconds, every 10 minutes.

D. Input Voltage Tolerance: Plus 10 percent/minus 15 percent of nominal input voltage range.

E. Rated Frequency: 50 Hz to 60 Hz, plus/minus 5 percent [; operate from 40 to 72 Hz when powered by standby or emergency generators].

F. Displacement Power Factor: 0.97, minimum.

G. Harmonics Mitigation:

1. Standard Drive Units
   a. Altivar Process ATV630 or equal
   b. Provide integral impedance of 3 percent, minimum.
   c. Current Total Harmonic Distortion (THD-I): Less than 48 percent at 80 to 100 percent load in accordance with IEC 61000-3-12.
2. Compact Drive Systems
   a. Altivar Process ATV660
   b. Available Ratings: 100 hp and below at 460 VAC.
   c. Provide integral impedance of 3 percent, minimum, for current total harmonic distortion (THD-I) less than 48 percent at 80 to 100 percent load in accordance with IEC 61000-3-12.
   d. Provide 6-pulse bridge rectifier design with additional line reactors integral to enclosure for total equivalent impedance of 5 percent, minimum, and current total harmonic distortion (THD-I) less than 26 percent at 100 percent load.

3. Low Harmonic Compact Drive Systems with Passive Harmonic Filter
    a. Altivar Process ATV660 or equal.
    b. Available Ratings: 100 hp and below at 460 VAC.
    c. Provide 6-pulse bridge rectifier design with integral dedicated harmonic filter including contactor for capacitor control.
    d. Current Total Harmonic Distortion (THD-I): Less than 5 percent.
4. Low Harmonic Drive Systems with Active Front End
    a. Altivar Process ATV680 or equal.
    b. Available Ratings: From 125 hp to 900 hp.
    c. Provide 3-level, active front end (AFE) rectification with integral power modules and reverse blocking IGBTs.
    d. Current Total Harmonic Distortion (THD-I): Less than 3 percent in accordance with IEEE 519.

H. Surge Immunity: IEC 61000-4-5, Level 3.

I. Comply with SEMI F47 for degraded running operation during undervoltage conditions.
1. 50 percent undervoltage for up to 200 milliseconds.
2. 30 percent undervoltage for up to 500 milliseconds.
3. 20 percent undervoltage for up to 1 second.

J. Speed Range:
1. Motor Quadrant: 1:100 in sensorless vector control.
2. Generator Quadrant: 1:50 in sensorless vector control.

K. Speed Accuracy: Plus/minus 10 percent of nominal motor slip in sensorless vector control.

L. Torque Control Accuracy: Plus/minus 15 percent in sensorless vector control for AC motors.

2.9 APPLICATION REQUIREMENTS

A. Supported Motor Control Types:
1. Volts per hertz vector control, standard.
2. Volts per hertz vector control, 5 points.
3. Volts per hertz vector control, quad.
4. Synchronous motor control.
5. Volts per hertz vector control, energy savings.

B. Provide real time clock management with battery backup.

C. Support automatic tuning of motor parameters through measurement of motor without rotation, and without disconnection of load from motor.

D. Provide functionality adjustable within drive parameters to reduce voltage surges on motor cables.

E. Voltage Reflection Suppression: Provide AC chokes and filters as required for installation and motor requirements.

1. Motors Complying with IEC TS 60034-25 or NEMA MG 1 Part 31:
    a. Unshielded Motor Cable Length up to 500 feet (150 m): Manage with VFD functionality.
    b. Unshielded Motor Cable Length up to 1,000 feet (300 m): Provide AC choke.
    c. Unshielded Motor Cable Length up to 1,640 feet (500 m): Provide dV/dt filter.
    d. Unshielded Motor Cable Length up to 3,280 feet (1000 m): Provide sinus filter.
2. Motors not Complying with IEC TS 60034-25 or NEMA MG 1 Part 31.
    a. Unshielded Motor Cable Length up to 164 feet (50 m): Provide dV/dt filter.
    b. Unshielded Motor Cable Length up to 3,280 feet (1000 m): Provide sinus filter.

F. Protection:

1. Listed as complying with UL 508 or UL 61800-5-1 for use on distribution systems.
2. Short Circuit Current Rating:
    a. Coordinated in accordance with UL 61800-5-1 and NEMA ICS 7.1.
    b. Minimum Short Circuit Current Rating:
        1) Standard Drive Units: Up to 65 kA depending on circuit protection device type.
        2) Compact Drive Systems 100 kA.
        3) Low Harmonic Drive Systems with Active Front End: 100 kA.
3. Micro-Short Voltage Sag Immunity: Comply with SEMI F47.
4. Upon power-up, automatically test for valid operation of memory, option module, loss of analog reference input, loss of communication, DC to DC power supply, control power, and precharge circuit.
5. Protect against short circuits between output phases and ground, and logic and analog outputs.
6. Provide selectable ride through function enabling logic to maintain control for minimum of one second without tripping.
7. Deceleration Mode: Programmable for normal and trip conditions.
8. Stop Modes: Freewheel stop, fast stop.

9. Upon loss of analog process follower reference signal, trip and/or operate at user-defined speed set by software programmed speed settings or last speed.
10. Integrate protection against IGBT and heat sink overtemperature.
11. Solid State Thermal Protection: Listed as complying with IEC 61800-5-1, Class 10 overload protection; comply with IEC 60947-2.
12. Provide motor thermal memory retention function.
13. Support protection of motor with temperature probes connected.
14. Support limiting motor surge to twice DC bus voltage.
15. Provide internal error detection.
16. IGBT Protection:
    a. Overcurrent protection.
    b. Checkup sequence.
    c. Checkup sequence before PWM enable sequence.
    d. Overheat protection.
17. Current Protection:
    a. Phase short circuit protection.
    b. Ground protection.
    c. Overcurrent protection.
18. Voltage Error Protection:
    a. Mains overvoltage protection.
    b. Mains undervoltage protection.
    c. DC bus overvoltage protection.
    d. DC bus precharge protection.
19. Thermal Protection:
    a. Overtemperature protection.
    b. Fan management.
    c. Switching frequency management.
20. Motor Protection Functions:
    a. Motor output phase detection.
    b. Motor surge voltage.
    c. Motor overload detection.
    d. Motor stall protection.
21. Application Protection Functions:
    a. Catch-on-fly function.
    b. Mains input phase lost protection.

c. Motor overspeed input protection.

d. Current limitation.

e. Power limitation.

f. Reverse inhibition.

g. Underload protection.

h. Overload protection.

i. External error management.

j. Loss of follower signal.

k. Thermal sensor management.

l. PID feedback.

m. Customer-defined input.

2.10 CONTROL AND INTERFACE REQUIREMENTS

A. Indicators:

1. LED near connection point of device that displays when hazardous voltage is present.
2. Three LEDs for local diagnostics.
3. Three dual-color LEDs for embedded communication status.
4. Four dual-color LEDs for optional communication status.

B. User Interface:

1. Provide detachable UL 50E Type 12/IEC 60529 IP65 rated bi-color backlit graphical user interface terminal with keypad and capacitive wheel for monitoring, annunciation, and configuration. Change graphical display to red backlit color when alarm occurs.
2. Door-mount interface with 7/8 inch (22 mm) hole.
3. Provide “Simply Start' menu for commissioning; provide accessible parameter setting with plain text messaging and actual setting range.
4. Support password protection via keypad.
5. Support saving and downloading VFD configurations and porting them to other VFDs.
6. Provide mini-USB port for mass storage or PC device connection.
7. Self-Diagnostic Capabilities: Display alarms, errors, and warnings as they occur and store minimum of 15 last messages in memory; accessible by PC maintenance tools or web server with flash record for data logging expertise.
8. Utilize identical user interfaces throughout power range to avoid user confusion and need for training in several different units.
9. Display messages in plain text; support multiple languages including English, French, and Spanish.

10. Provide QR code or equivalent for access to enhanced diagnostics, documentation, and customer service.

C. Control Interface:

1. Interface with automation systems to monitor, control, display, and record data for use in processing reports. Retain settings within nonvolatile memory.

2. Speed Command and Reference Control Sources:

a. I/O terminals.

b. Communication network.

c. Web server.

d. Remote graphic display terminal.

3. Inputs/Outputs:

a. Analog Inputs: Three programmable 0(4)-20 mA or 0-10 VDC.

1) Two analog inputs also programmable for temperature sensors (PTC, PT100, PT1000, KTY84).

b. Analog Outputs: Two programmable 0(4)-20 mA or 0-10 VDC.

c. Discrete Inputs: Six programmable isolated logic inputs, sink or source.

1) Two discrete inputs also programmable as 0-30 kHz pulse inputs.

2) Two discrete inputs dedicated for safe torque off safety function in accordance with IEC 61508-1 SIL3.

d. Discrete Outputs: Three programmable relay contacts.

4. Programmable Analog Input Available Assignments:

a. Speed reference.

b. Summing reference.

c. Subtracting reference.

d. Multiplying reference.

e. Torque reference.

f. Torque limitation.

g. PID feedback.

h. Manual PID reference.

i. PID speed reference.

j. Forced local reference.

5. Programmable Analog Output Available Assignments:

a. Motor current.

b. Motor frequency.

c. Motor torque, signed or unsigned.

d. Motor power.
e. Motor voltage.
f. Output frequency, signed or unsigned.
g. PID error.
h. PID feedback.
i. PID output.
j. PID reference.
k. Ramp output.
l. Signed ramp.
m. Drive thermal state.
n. Motor thermal state.
o. Pressure sensor.
p. Flow sensor.

6. Programmable Discrete Input Available Assignments:
   a. Run.
   b. Forward.
   c. Reverse.
   d. Jog.
   e. Preset speeds.
   f. Reference switching.
   g. Ramp switching.
   h. Error reset.
   i. Error inhibition.
   j. Product reset.
   k. PID regulation mode, auto.
   l. PID speed regulation mode, manual.
   m. PID integral reset.
   n. Preset PID reference.
   o. Sleep/wake-up.
   p. Activate sleep mode by flow detection.
   q. Analog torque limitation activation.
   r. Torque reference sign.
   s. Command switching.
   t. Parameter sets selection.
   u. Fast stop.

v. DC injection.
w. Freewheel stop.
x. Plus speed.
y. Minus speed
z. External error.
aa. Prefluxing.
bb. Forced local control.
cc. Current limitation activation.
dd. Output contactor feedback.
ee. Reference memorization.
ff. Auto-tuning.
gg. Forced operation.
hh. Underload detection.
ii. Overload detection.
jj. Limiting low speed operating time.
kk. Switching frequency, noise reduction.
ll. Drive lock assignment.
mm. Outlet pressure switch select.
nn. Pipe fill.
oo. External anti-jam trigger.
pp. Dry running/no flow switch select.
qq. Pump low flow/no flow switch select.

7. Programmable Discrete Output Available Assignments:
   a. Ready.
   b. Drive running.
   c. Frequency reference attained.
   d. Current attained.
   e. High speed attained.
   f. Drive error.
   g. Frequency threshold attained.
   h. Torque sign.
   i. Motor thermal state attained.
   j. Drive thermal state attained.
   k. Torque or current limitation attained.
   l. Output contactor command.

m. Input contactor command.

n. Current present.

o. Power removed.

p. Alarm groups.

q. Alarms: Load slipping, 4-20 mA loss, brake control, external error, PTC, PID error, PID feedback, IGBT temperature, undervoltage, torque control, drive temperature, braking resistor, fan counter, fan feedback, customer warning, power threshold, and electrical power drift.

r. Active configuration.

s. Active parameter set.

t. Active channel.

u. DC bus charged.

v. DC bus charging.

w. Water Command: Jockey pump, priming pump.

x. Water Running: Anti-jam, pipe fill, priming pump, and jockey pump.

y. Water Warning: Dry running, flow, inlet pressure, outlet pressure, pump cycling, anti-jam, and outlet pressure switch.

8. Safety Inputs:

a. Two inputs dedicated to safe torque off (STO) safety function, which prohibits unintended equipment operation, in accordance with IEC 61508-1 SIL3.

b. Comply with ISO 13849-1 and ISO 13849-2 (PL e).

c. Manufacturer to provide certified schematics and list of devices to comply with IEC 60204-1 stopping category 0 and 1.

d. Integrate safety contacts in accordance with EN-81 (SERIES).

D. Communications:

1. Provide one Modbus and one Ethernet Modbus TCP communications port.

2. Provide the following as required for communications:

a. Ethernet IP or Modbus TCP, RJ45 dual port for daisy chain.

b. Profibus DP V2, SUB-D9 connection, complying with drive profile networking.

c. Profinet, RJ45 dual port for daisy chain.

d. DeviceNet, five terminal points.

e. CanOpen daisy Chain, RJ45 dual port for daisy chain.

f. CanOpen SUB-D9 connection.

g. CanOpen Open terminals, five terminal points.

3. Ethernet Ports: Comply with IPv6, provide capability for web server access and network management via SNMP and clock synchronization.

4. Embedded Web Server:
    a. Support enhanced diagnostic, mini usb, parameter access, and energy management.
    b. Support creation of user-defined custom dashboard for viewing drive and process status through tables, charts, and graphical views.
    c. Support export of data in standard table format using web server, for energy consumption information and error/warning history.
5. Comply with Cyber Security Management ISA Secure/Achilles.
6. Capable of providing Wi-Fi connectivity for wireless diagnostic, configuration, and parameter access.
7. Provide communications modules[capable of being] remotely powered by separate external 24 VDC source for continued communications with drive power supply off.
8. Integration Connectivity:
    a. DHCP protocol for fast device replacement.
    b. DTM library in accordance with standard FDT technology.

E. Configuration:
1. Support independent command and speed reference signals from:
    a. Terminals.
    b. Modbus port.
    c. Ethernet port.
    d. Communication option card.
    e. Keypad display.
2. Speed Setpoint Function:
    a. Maximum output frequency function.
    b. Low and high speed scaling and limitation function.
    c. Jump frequency.
    d. Speed summing references function.
    e. Preset-speed references function.
    f. Jog function.
    g. Up-down speed references.
3. Stop Function:
    a. Deceleration ramp on power loss.
    b. Freewheel stop.
    c. Stop by DC injection at motor stop detection.
    d. Stop by DC injection by logic input.
    e. Stop on deceleration ramp adaptation.

4. Acceleration/Deceleration, Time-Adjustable Ramp Function:
    a. Ramp Type: Linear ramp, S shape ramp, with U or customized profile.
    b. Ramp deceleration adaptation.
    c. Ramp switching.
5. Application Programming Dedicated to Pumps:
    a. Pump Control and Monitoring Functions:
        1) Centrifugal pump characteristics and configurations.
        2) Pump Monitoring Function: Define data relevant for pump including acceleration, low speed, and high speed.
        3) Application Units Function: Define units used in applications.
        4) Pump Cyclic Start Protection: Protect pump against excessive restarts in dedicated time period.
        5) Multi-pump functions.
    b. Pump Protection Functions:
        1) Anti-Jam Function: Remove automatically clogging substances from pump impellers.
        2) Pipe Cleaning Function: Start pump regularly to avoid sedimentation in pump impeller.
        3) Cavitation pump protection.
        4) Inlet protection to avoid system dry running.
    c. Application Control Functions:
        1) Stop-and-Go Function: Reduce consumption in standby mode.
        2) Pulse input to connect flow meter.
        3) Process Control (PID) Function: Maintain process at given pressure or flow reference.
        4) Flow Limitation Function: Limit consumption of water.
        5) Friction Loss Compensation Function: Compensate for pressure losses in pipes due to friction.
        6) Pipe Fill Function: Manage smooth control during pipe filling and lessen effects of water hammer.
        7) Sleep Wake-Up Function: Manage periods of application when process demand is low and when not needed.
        8) Low Demand Function: Define periods of application when process demand is low to save energy.
        9) Jockey Pump Control Function: Start jockey pump, during sleep period, to maintain emergency service pressure or demand including low water.
        10) Sensor Management: Define use to drive inputs to manage pressure sensor or flow sensor.

d. Application Protection Functions:

1) High Flow Protection Function: Detect pipe burst or detect running outside normal working area.

2) Outlet Pressure Protection Function: Fix minimum and maximum pressure.

e. Pump Curve Input to Optimize Pump Performance:

1) Input and storage of pump characteristics including five points of pump curve.

2) Best Efficiency Point (BEP) Function: Run in optimum conditions and detect deviation from that point.

F. Diagnostics and Configuration:

1. Windows-Based PC Software: Support setting and modifying of parameters, controlling drive, reading actual values, and analyzing trends; support wired or wireless connection to VFD.

2. Display faults in plain text on help screens for troubleshooting; codes are not acceptable.

3. Provide real time clock management for time stamping of detected errors.

4. Display detected errors with QR codes for troubleshooting.

5. Provide LED lights to indicate VFD status.

6. Support dynamic display of I/O status.

G. Energy Management:

1. Data Logging Function: Keep files ready for maintenance or user.

2. Provide energy management information through web server, keypad, facet for SCADA, or communication networks.

3. Support display of energy efficiency and energy management chart.

a. Report in KW.

b. Energy History: Instant, weekly, monthly, and yearly.

c. Trend base on variation/time.

d. Power Measurement Accuracy: Less than 5 percent.

4. Support display of efficient set point for pump based on pump characteristics.

5. Support display of efficiency board including CO2 savings, savings viewer, and return of investment.

PART 3 - EXECUTION

3.1 GENERAL

A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of Specification Division 26 and Drawings.

3.2 EXAMINATION

A. Examine equipment exterior and interior for damage, including but not limited to, structure, moisture, and mildew.

B. Examine for conditions detrimental to completion of work.

3.3 INSTALLATION

A. Install equipment in accordance with manufacturer’s written instructions.

3.4 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements.

B. Manufacturer Services: Provide services of manufacturer's field representative to perform functional testing, commissioning, and first parameter adjusting.

1. Include necessary material, equipment, labor, and technical supervision.
2. Replace damaged or malfunctioning equipment and report discrepancies or installation issues.
3. Identify motor controllers with label indicating inspection/testing agency and date of service.

3.5 OPERATIONAL READINESS TESTING:

A. Inspect and test equipment and associated systems for conformance to Contract Documents, including equipment manufacturer’s recommendations, and readiness for operation.

1. Visually inspect for physical damage and proper installation.
2. Perform tests in accordance with manufacturer's instructions.
3. Perform tests to verify compliance with Contract Documents.
4. Perform tests to verify equipment is ready for operation.

5. Touch-up paint chips and scratches with manufacturer-supplied paint.

3.6 CLOSEOUT ACTIVITIES

A. Functional Demonstration Testing: Demonstrate proper operation of transformers and associated systems to Owner's designated representative and Engineer, observing and documenting compliance with Contract Documents.

B. Training:

1. Train Owner's personnel on operation and maintenance of system.
2. Provide not less than one session(s) with four hours of classroom and hands-on training.

C. Provide sufficient time and detail in each session to cover the following at minimum:

1. Operation theory.
2. Major equipment components.
3. Equipment operation.
4. Equipment configurations.
5. Maintenance, troubleshooting, and repair.
6. Component-level parts replacement.

3.7 PROTECTION

A. Protect installed motor controllers from subsequent construction operations.

END OF SECTION 26 29 23

SECTION 26 32 13 – GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, configuration and installation for the engine-driven generator set as required for the complete performance of the work, as shown on the drawings, as specified herein, and as specified elsewhere for the assemblies or systems comprised of the components specified herein.

B. RELATED SECTIONS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
2. Division 26 Section "Common Work Results for Electrical".
3. Section 26 36 23 Automatic Transfer Switches

1.2 REFRENCES

A. The engine-driven generator set in this specification are designed and manufactured according to latest revision of the following standards (unless otherwise noted).

1. National Fire Protection Association (NFPA) 70, National Electrical Code (NEC)
2. NFPA 37 Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
3. NFPA 110 Standard for Emergency and Standby Power Systems.
4. Institute of Electrical and Electronics Engineers (IEEE)
5. National Electrical Manufacturers Association (NEMA)
6. *-American National Standards Institute (ANSI)
7. PA Tier Levels for Non-Road Engines

1.3 DEFINITIONS

A. Emergency Standby Power (ESP): Per ISO 8528: The maximum power available during a variable electrical power sequence, under the stated operating conditions, for which a generating set is capable of delivering in the event of a utility power outage or under test conditions for up to 200 hours of operation per year with the maintenance intervals and procedures being carried out as prescribed by the manufacturers. The permissible average power output (Ppp) over 24

hours of operation shall not exceed 70 percent of the ESP unless otherwise agreed by the RIC engine manufacturer.

B. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter

1.4 ACTION SUBMITTALS

A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Thermal damage curve for generator.

2. Time-current characteristic curves for generator protective device.

3. Sound test data, based on a free field requirement.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.

2. Wiring Diagrams: Control interconnection, Customer connections.

1.5 INFORMATIONAL SUBMITTALS

A. Source quality-control test reports.

1. Certified summary of prototype-unit test report. See requirements in Part 2 "Source Quality Control" Article Part A. Include statement indicating torsional compatibility of components.
2. Certified Test Report: Provide certified test report documenting factory test per the requirements of this specification, as well as certified factory test of generator set sensors per NFPA110 level 1.
3. List of factory tests to be performed on units to be shipped for this Project.
4. Report of exhaust emissions and compliance statement certifying compliance with applicable regulations.

B. Warranty:

1. Submit manufacturer’s warranty statement to be provided for this Project.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 4 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

D. Comply with NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).

E. Comply with NFPA 70 (National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702).

F. Comply with NFPA 110 (Emergency and Standby Power Systems) requirements for Level 1 emergency power supply system.

1.7 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 32.0 deg F to 113.0 deg F.
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 850.0 feet.

1.8 WARRANTY

A. Manufacturer shall provide base warranty coverage on the material and workmanship of the generator set for a minimum of twenty-four (24) months for Standby product and twelve (12) months for Prime/Continuous product from registered commissioning and start-up.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The basis for this specification is Cummins Power Generation equipment. Other manufactures' products of equivalent quality, dimensions and operating features may be acceptable, at the Engineer's discretion, if they comply with all requirements specified.

B. Other pre-approved manufacturers.

1. Caterpillar
2. Kohler

2.2 ENGINE-GENERATOR SET (INFLUENT PUMP STATION GENERATOR)

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

1. Rigging Information: Indicate location of each lifting attachment, generator-set center of gravity, and total package weight in submittal drawings.

C. Capacities and Characteristics:

1. Power Output Ratings: Electrical output power rating for Standby operation of not less than 600kW, at 80 percent lagging power factor, 277/480, Series Wye, Three phase, 4 -wire, 60 hertz.
2. Alternator shall be capable of accepting maximum 3264.0 kVA in a single step and be capable of recovering to a minimum of 90% of rated no load voltage. Following the application of the specified kVA load at near zero power factor applied to the generator set.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of components. The engine-generator nameplate shall include information of the power output rating of the equipment.

D. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 1.0 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 5 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 5 seconds. On application of a 100% load step the generator set shall recover to stable voltage within 10 seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Not more than 6 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 1 second. On application of a 100% load step the generator set shall recover to stable frequency within 10 seconds.

6. Output Waveform: At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.

7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 8 seconds without damage to generator system components. For a 1-phase, bolted short circuit at system output terminals, system shall regulate both voltage and current to prevent over-voltage conditions on the non-faulted phases.

8. Start Time: Comply with NFPA 110, Level 1, Type 10, system requirements.

9. Ambient Condition Performance: Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.

2.3 ENGINE-GENERATOR SET (TREATMENT PLANT GENERATOR)

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

1. Rigging Information: Indicate location of each lifting attachment, generator-set center of gravity, and total package weight in submittal drawings.

C. Capacities and Characteristics:

1. Power Output Ratings: Electrical output power rating for Standby operation of not less than 1000kW, at 80 percent lagging power factor, 277/480, Series Wye, Three phase, 4 -wire, 60 hertz.

2. Alternator shall be capable of accepting maximum 5521.0 kVA in a single step and be capable of recovering to a minimum of 90% of rated no load voltage. Following the application of the specified kVA load at near zero power factor applied to the generator set.

3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of components. The engine-generator nameplate shall include information of the power output rating of the equipment.

D. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 1.0 percent of rated output voltage from no load to full load.

2. Transient Voltage Performance: Not more than 6 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state

operating band within 1 second. On application of a 100% load step the generator set shall recover to stable voltage within 10 seconds.

3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.

4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

5. Transient Frequency Performance: Not more than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 2 seconds. On application of a 100% load step the generator set shall recover to stable frequency within 10 seconds.

6. Output Waveform: At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.

7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 8 seconds without damage to generator system components. For a 1-phase, bolted short circuit at system output terminals, system shall regulate both voltage and current to prevent over-voltage conditions on the non-faulted phases.

8. Start Time: Comply with NFPA 110, Level 1, Type 10, system requirements.

9. Ambient Condition Performance: Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.

2.4 ENGINE

A. Fuel: Natural Gas

B. Rated Engine Speed: 1800RPM.

C. Lubrication System: The following items are mounted on engine or skid:

1. Lube oil pump: shall be positive displacement, mechanical, full pressure pump.

2. Filter and Strainer: Provided by the engine manufacturer of record to provide adequate filtration for the prime mover to be used.

3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Engine Fuel System: The engine fuel system shall be installed in strict compliance to the engine manufacturer’s instructions

E. Governor: Adjustable isochronous, with speed sensing. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.

F. Cooling System: Closed loop, liquid cooled

1. The generator set manufacturer shall provide prototype test data for the specific hardware proposed demonstrating that the machine will operate at rated standby load in an outdoor ambient condition of 40 deg C.

2. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

3. Size of Radiator overflow tank: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.

4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.

5. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

6. Duct Flange: Generator sets installed indoors shall be provided with a flexible radiator duct adapter flange.

G. Muffler/Silencer: Selected with performance as required to meet sound requirements of the application, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements. For generator sets with outdoor enclosures the silencer shall be inside the enclosure.

H. Air-Intake Filter: Engine-mounted air cleaner with replaceable dry-filter element and restriction indicator.

I. Starting System: 12 or 24V, as recommended by the engine manufacturer; electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.

2. Cranking Cycle: As required by NFPA 110 for level 1 systems.

3. Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.

4. Battery Compartment: Factory fabricated of metal with acid-resistant finish.

5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation. The battery charging alternator shall have sufficient capacity to recharge the batteries with all parasitic loads connected within 4 hours after a normal engine starting sequence.

6. Battery Chargers: Unit shall comply with UL 1236, provide fully regulated, constant voltage, current limited, battery charger for each battery bank. It will include the following features:

   a. Operation: Equalizing-charging rate based on generator set manufacturer's recommendations shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.

   b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 20 deg C to plus 40 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.

   c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.

   d. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

   e. Provide LED indication of general charger condition, including charging, faults, and modes. Provide a LCD display to indicate charge rate and battery voltage. Charger shall provide relay contacts for fault conditions as required by NFPA110.

   f. Enclosure and Mounting: NEMA, Type 1, wall-mounted cabinet.

2.5 CONTROL AND MONITORING

A. Engine generator control shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit.

B. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. (Switches with different configurations but equal functions are acceptable.) When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.

C. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.

D. Configuration: Operating and safety indications, protective devices, system controls, engine gages and associated equipment shall be grouped in a common control and monitoring panel. Mounting method shall isolate the control panel from generator-set vibration. AC output power circuit breakers and other output power equipment shall not be mounted in the control enclosure.

E. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:

1. AC voltmeter (3-phase, line to line and line to neutral values).
2. AC ammeter (3-phases).
3. AC frequency meter.
4. AC kVA output (total and for each phase). Display shall indicate power flow direction.
5. Ammeter-voltmeter displays shall simultaneously display conditions for all three phases.
6. Emergency Stop Switch: Switch shall be a red "mushroom head" pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating.
7. Fault Reset Switch: Supply a dedicated control switch to reset/clear fault conditions.
8. DC voltmeter (alternator battery charging).
9. Engine-coolant temperature gauge.
10. Engine lubricating-oil pressure gauge.
11. Running-time meter.
12. Generator-voltage and frequency digital raise/lower switches. Rheostats for these functions are not acceptable. The control shall adjustment of these parameters in a range of plus or minus 5% of the voltage and frequency operating set point (not nominal voltage and frequency values.) The voltage and frequency adjustment functions shall be disabled when the paralleling breaker is closed.
13. AC Protective Equipment: The control system shall include over/under voltage, reverse kVAR, reverse kW, overload (kW) short circuit, over current, loss of voltage reference, and over excitation shut down protection. There shall be a ground fault alarm for generator sets rated over 1000 amps, overload warning, and overcurrent warning alarm.
14. Status LED indicating lamps to indicate remote start signal present at the control, existing shutdown condition, existing alarm condition, not in auto, and generator set running.
15. A graphical display panel with appropriate navigation devices shall be provided to view all information noted above, as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall also include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.
16. Panel lighting system to allow viewing and operation of the control when the generator room or enclosure is not lit.
17. DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control and annunciate low or high voltage conditions. It shall also provide

an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking).

F. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.

1. Overcrank shutdown.
2. Coolant low-temperature alarm.
3. Control switch not in auto position.
4. Battery-charger malfunction alarm.
5. Battery low-voltage alarm.

G. Remote Alarm Annunciator: Comply with NFPA 110. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Overcurrent Protection: The generator set shall be provided with a UL Listed/CSA Certified protective device that is coordinated with the alternator provided to prevent damage to the generator set on any possible overload or overcurrent condition external to the machine. The protective device shall be listed as a utility grade protective device under UL category NRGU. The control system shall be subject to UL follow-up service at the manufacturing location to verify that the protective system is fully operational as manufactured. Protector shall perform the following functions:

1. Initiates a generator kW overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
2. Under single phase or multiple phase fault conditions, or on overload conditions, indicates an alarm condition when the current flow is in excess of 110% of rated current for more than 10 seconds.
3. Under single phase or multiple phase fault conditions, operates to switch off alternator excitation at the appropriate time to prevent damage to the alternator.
4. The operator panel shall indicate the nature of the fault condition as either a short circuit or an overload.
5. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot greater than 120% of nominal voltage.
6. The protective system provided shall not include an instantaneous trip function.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H

D. Temperature Rise: 125C / Class H environment.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over speed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Permanent Magnet Generator (PMG) shall provide excitation power for optimum motor starting and short circuit performance.

G. Enclosure: Drip-proof.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified. The voltage regulation system shall be microprocessor-controlled, 3-phase true RMS sensing, full wave rectified, and provide a pulse-width modulated signal to the exciter. No exceptions or deviations to these requirements will be permitted.

I. The alternator shall be provided with anti-condensation heater(s) in all applications where the generator set is provided in an outdoor enclosure, or when the generator set is installed in a coastal or tropical environment.

J. Subtransient Reactance: 12 percent maximum, based on the rating of the engine generator set.

2.8 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Sound Attenuated Steel housing. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Instruments, control, and battery system shall be mounted within enclosure.

B. Construction:

1. Louvers: Equipped with bird screen to permit air circulation when engine is not running while excluding birds and rodents.
2. Hinged Doors: With padlocking provisions. Restraint/Hold back hardware to prevent door to keep door open at 180 degrees during maintenance. Rain lips over all doors.
3. Exhaust System:
    a. Muffler Location: Within enclosure.
4. Hardware: All hardware and hinges shall be stainless steel.
5. Mounting Base: Suitable for mounting on sub-base fuel tank or housekeeping pad.
6. A weather protective enclosure shall be provided which allows the generator set to operate at full rated load with a static pressure drop equal to or less than 0.5 inches of water.

C. Engine Cooling Airflow through Enclosure: Housing shall provide ample airflow for engine generator operation at rated load in an ambient temperature of 40 deg C.

D. Sound Performance:

1. Influent Pump Station Generator: Reduce the sound level of the engine generator while operating at full rated load to a maximum of 75 dBA measured at any location 7 m from the engine generator in a free field environment.
2. Treatment Plant Generator: Reduce the sound level of the engine generator while operating at full rated load to a maximum of 80 dBA measured at any location 7 m from the engine generator in a free field environment.

E. Electrical Provisions

1. Compliance with NEC: Package shall comply with the requirements of the National Electrical Code for all wiring materials and component spacing.
2. Provide an internally mounted and wired electrical distribution panel to serve the engine generator and enclosure; including:
   a. 100 amp distribution panelboard connected to a 120/208VAC utility service by the installer.
   b. Two duplex GFI receptacles, one inside the enclosure, and a weatherproof receptacle on the outside of the enclosure.
   c. Factory wired normal AC service from the panelboard to the engine coolant heater, alternator heater, and battery charger.
   d. Interior Lights with Switch: Two three-way switches controlling three AC lamps mounted in vapor tight and gasketed fixtures
3. External Electrical Connections: All power and control interconnections shall be made within the perimeter of the enclosure.

F. Site Provisions:

1. Lifting: Complete assembly of engine generator, and enclosure shall be designed to be lifted into place as a single unit, using spreader bars.

2.9 VIBRATION ISOLATION DEVICES

A. Vibration Isolation: Generators installed on grade shall be provided with elastomeric isolator pads integral to the generator, unless the engine manufacturer requires use of spring isolation.

2.10 FINISHES

A. Indoor and Outdoor Enclosures and Components: Powder-coated and baked over corrosion-resistant pretreatment and compatible primer. Manufacturer’s standard color or as directed on the drawings.

2.11 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters. In addition, the equipment engine, skid, cooling system, and alternator shall have been subjected to actual prototype tests to validate the capability of the design under the abnormal conditions noted in NFPA110. Calculations and testing on similar equipment which are allowed under NFPA110 are not sufficient to meet this requirement.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test engine generator set manufactured for this Project to demonstrate compatibility and functionality.
2. Full load run.
3. Maximum power.
4. Voltage regulation.
5. Steady-state governing.
6. Single-step load pickup.
7. Simulated safety shutdowns.
8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLTION

A. Comply with packaged engine-generator manufacturers' written installation, application, and alignment instructions and with NFPA 110.

B. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.

C. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

D. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.

E. Equipment shall be initially started and operated by representatives of the manufacturer. All protective settings shall be adjusted as instructed by the consulting engineer.

F. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

G. On completion of the installation by the electrical contractor, the generator set supplier shall conduct a site evaluation to verify that the equipment is installed per manufacturer's recommended practice.

3.2 ON-SITE ACCEPTANCE TEST

A. The complete installation shall be tested to verify compliance with the performance requirements of this specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer. The Engineer shall be notified in advance and shall have the option to witness the tests. The generator set manufacturer shall provide a site test specification covering the entire system. Tests shall include:

B. Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.

C. Installation acceptance tests to be conducted on site shall include a "cold start" test, a two hour full load (resistive) test, and a one-step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.

D. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

3.3 TRAINING

A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner.

3.4 FIELD QUALITY CONTROLS

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

3.5 SERVICE AND SUPPORT

A. The generator set supplier shall maintain service parts inventory for the entire power system at a central location which is accessible to the service location 24 hours per day, 365 days per year. The manufacturer of the generator set shall maintain a central parts inventory to support the supplier, covering all the major components of the power system, including engines, alternators, control systems, paralleling electronics, and power transfer equipment.

B. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical power system replacement parts in the local service location. Service vehicles shall be stocked with critical replacement parts. The service organization shall be on call 24 hours per day, 365 days per year. The service organization shall be physically located within 4 miles of the site.

C. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

END OF SECTION 26 32 13

SECTION 26 35 26 – ACTIVE HARMONIC FILTER

PART 1 - GENERAL

1.1 SUMMARY

A. This specification defines the requirements for active harmonic filter systems to meet IEEE-519-2022 electrical system requirements for harmonic current limits. The active harmonic filter shall have the capability to maintain power factor between 0.0 to 1.0, either leading or lagging when operated within limits.

1.2 STANDARDS

A. The active harmonic filter system shall be designed in accordance with the applicable sections of the following documents.

1. IEEE std 519-2022
2. UL 508 (Open Panel, Type 1) or UL 508A (Type 3R, Type 12)
3. ARRA – American Recovery Investment Act
4. Manufactured in the USA

B. The products shall include third party approvals by cULus.

1.3 SYSTEM DESCRIPTION

A. Voltage: 208/240/380-415/480/600 Volts +/- 10%, 50/60 Hz, 3 phase, 3 wire plus ground.

B. Current Rating: Provide the rated current as indicated on the drawings.

C. Current Transformers:

1. Two current transformers are required and mounted in phases A & C.
2. Current transformers are an integral part of the active harmonic filter. When current transformers are installed external to the active harmonic filter equipment, the contractor shall be responsible for the installation of manufacturer provided current transformers.
3. Current ratings of the current transformers shall be according to full load current of the circuit on which installed. Primary rating of 500A, 1000A, 3000A, or 5000A with a secondary rating of 5A are acceptable.
4. Current transformers rated for 400 Hertz shall be used.

1.4 MODE OF OPERATION

A. The active harmonic filter shall electronically supply the non-fundamental current demanded by the non-linear load that results in a near sinusoidal current being drawn from the supply.

B. The active filter shall monitor all three phases of the low voltage line current in real time and process the measured harmonics by means of a dual Digital Signal Processor (DSP) based system.

C. The system shall be operating under closed loop control to such that the active filter cannot be overloaded.

1.5 PERFORMANCE REQUIREMENTS

A. Response Time:

1. In a steady state condition, the active harmonic filter shall have a response time of less than one (1) line cycle.

2. In the event of a load change or transient condition, the response time shall be within three (3) line cycles.

B. Input Power:

1. Voltage: 480 Volt, 3 phase, 3 wire plus ground

2. Voltage Tolerance: +/- 10% of nominal

3. Frequency: automatically adapted to 60Hz, +/- 3%

4. Input Protection:

a. 30A or 50A units: Fuse Block: 200 kAIC

b. All other ratings: Circuit Breaker: 65 kAIC (min), or 100 kAIC Rated (if specified by part number's nomenclature) or Fused Disconnect (if specified by part number's nomenclature).

C. Output Performance

1. Performance of the active harmonic filter shall be independent of the impedance of the power source. All performance levels shall be attained whether on the AC lines, backup generator, or output of UPS.

2. Harmonic Correction:

a. Limit THD (I) to less than or equal to 3% while in closed loop control and filter is 50% or more loaded (requires 3% or higher inductive impedance per non-linear load).

b. Limit the 2nd through 50th order harmonic current to <5% TDD (or, if specified elsewhere, to the calculated level per IEEE Std 519) at each installed location indicated herein. Levels for individual harmonic orders

shall comply with respective levels established in ANSI/IEEE Std 519-2022.

c. Limit the THD (V) added to the electrical system immediately upstream of the active line conditioner location(s) to less than or equal to 5%. The active harmonic filter shall not correct for utility supplied voltage distortion levels.

3. When sized properly, reactive Current Compensation shall be capable of improving displacement power factor to a user programmable minimum value setpoint. The setpoint shall be programmable via the HMI to any value from 0.0 to 1.0, either leading or lagging.

1.6 ENVIRONMENTAL CONDITIONS

A. The active harmonic filter shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics or life.

1. Operating Ambient Temperature for Type 1 and 12 enclosure options: 00C (32°F) to 400C (104°F).

a. For 30A and 50A filters: 00C to 500C.

2. Operating Ambient Temperature for Type 3R enclosures: -200C to 400C.

a. For 30A and 50A filters: -200C to 500C.

b. For Type 3R enclosures with HMI mounted: 00C (32°F) to 400C (104°F).

3. Storage Temperature: -400C to 650C.

4. Relative Humidity: 0 to 95%, non-condensing.

5. Altitude: Operating to 1000 meters (3300 ft).

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Harmonic Filters shall be proven compatible with specified VFD units (TCI) or the same manufacturer as VFDs (Danfoss).

1. TCI

2. Danfoss

3. Approved equal

2.2 ENCLOSURE

A. Each filter shall be provided in a UL Type 1, 12, or 3R rated enclosure.

B. All enclosed units shall have means to prevent the door from being opened when the unit is energized. This can be achieved by one of these options:

1. A door-interlocked circuit breaker that provides power interruption when the door is opened. The circuit breaker shall be lockable in the power-off position. Units shall be disconnected from the power source by a disconnect device or circuit breaker contained in the power distribution center as defined by local and national codes for branch circuit protection. OR

2. A mechanism that locks the door when the unit is energized. The unit may be fed using an external disconnect or breaker. OR

3. A fuse block with a circuit breaker or disconnect external to the enclosure.

C. Freestanding units shall include lifting provisions by forklift truck and lifting lugs. Wall mount units weighing more than 80 pounds shall be equipped with a means of lifting, such as lifting lugs.

D. Door Mounted Digital HMI Operator Interface option.

E. All units shall be provided with a grounding lug. Grounding by the contractor is to be performed according to local and national standards.

F. The paint shall be the manufacturer’s standard type and color.

2.3 OPERATOR CONTROLS AND INTERFACE

A. The active harmonic filter shall require minimal field programming.

B. The active harmonic filter shall contain a color touch screen display with the following features:

1. Easily navigable screens, including Home, Status, Fault, and Setup screens.

2. Display voltage and current waveform data along with RMS metering data.

3. A gauge-based indicator of active filter current usage, from 0 to 100% of capacity. Dual state indications of nominal operation and "at capacity" operation.

4. An alarm history buffer saved in non-volatile memory. Buffer information shall persist between power outages, with a minimum of 128 event entries.

5. Ability to set the end user Line/Load CT ratio of the active harmonic filter system.

6. The Operator Interface shall show THD, Power Factor, RMS Current, RMS Voltage, and Fault History.

7. Ability to adjust the polarity and phase allocation of the A & C phase CTs to other phases via the HMI.

C. The active harmonic filter shall have the ability to operate in three (3) modes: i) harmonic correction only mode, ii) power factor correction only mode, or iii) combination harmonic and power factor mode. All three control modes shall be configurable from the local operator color touch screen display.

D. The active harmonic filter shall have a configurable relay-based run/stop command input in addition to the manual and auto run/stop commands. The active filter shall have a configurable relay-based fault output. Each contact shall be rated for 2.0 Amperes at 250 volts.

E. The filter shall have a configurable network-based run/stop command input in addition to the manual and auto run/stop commands.

F. The filter shall have the ability to load and save operational parameters in non-volatile persistent memory and the ability to revert to factory default parameter settings.

G. The filter shall possess an integrated industry standard serial TIA/EIA-485 / RS-485 fieldbus slave network connection such as Modbus RTU for remote monitoring and operation of the active filter.

H. The filter shall have the ability to communicate over a standard industrial Ethernet communications network such as Ethernet/IP or Modbus TCP/IP, when purchased with the standard industrial Ethernet communication option.

I. The filter shall have the ability to communicate over a standard industrial Fieldbus communications network such as DeviceNet, when purchased with the standard industrial Fieldbus communication option.

J. .The unit shall automatically begin to correct harmonic currents after power up without the need for operator intervention.

K. The unit shall have the ability to display trend history data for line voltage, line current, filter current, current THD, filter bus voltage, and filter heatsink temperature.

2.4 DESIGN

A. All active harmonic filters shall be defined as power electronic devices which consist of power semiconductors and a DC bus that acts to inject current into the AC line that will cancel undesirable harmonic currents drawn by the load. A DC bus shall store power for power semiconductor switching. A digital microcontroller shall control the operation of the power converter.

B. The active harmonic filter shall feature fully digital synchronous frame controls for selected harmonics to enhance drive load compatibility.

C. The active harmonic filter shall feature a fully digital, broadband current regulator with progressive gains to eliminate system resonance tuning issues and simplify startup and commissioning.

D. The active harmonic filter shall feature single processor control of all power electronic devices per a single active filter to reduce fault response latency and harmonic correction loop times.

E. Each unit shall be designed with over-current and current limiting self-protection. Operation shall continue indefinitely at manufacturer defined safe operating levels without trip off or destruction of the active harmonic filter.

F. Large units (capacity>350A) shall have built in redundancy so at least one half of the corrective current capacity is available after a normal single point fault.

G. Units shall detect heatsink temperature and have the ability to fold back the current limit based on the temperature measurement.

H. Two distinct levels of faults shall be employed: Critical and Non-critical levels. Non-critical level faults will provide automatic restart and a return to normal operation upon automatic fault clearance. Critical level faults stop the function of the unit and await operator action to restart.

I. Faults such as AC line power loss shall be automatically restarted upon power restoration. Upon removal of these fault conditions, the active line conditioner shall restart without user action.

J. All other faults shall be considered critical faults and stop the active harmonic filter. The run relay shall be disabled, and the fault relay enabled. Users shall be required to initiate a power reset (cycle power off and on) to restart the active harmonic filter.

K. The logic of the active harmonic filter shall monitor the load current by utilizing two (2) current transformers (CTs) mounted on phases A and C to direct the function of the power electronic converter.

L. Multiple active harmonic filters may be installed in parallel to inject current when the filters being paralleled are the same current rating. The units will function independently. If one unit is stopped or faulted, the remaining units will continue to operate normally.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Architect/Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

1 Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 INSTALLATION

A. Preparation and installation shall be in accordance with reviewed product data, final shop drawings, manufacturer's written recommendations, and as indicated on the Drawings.

1. Install low voltage active harmonic filters in accordance with the NEC and all applicable federal, state and local codes.

3.3 FIELD QUALITY CONTROL

A. Field inspection and testing shall be performed by certified technician from the manufacturer.

B. Perform start-up tests in accordance with manufacturer's instruction manual.

C. Document equipment nameplate and test data on the test report.

3.4 FACTORY TEST

A. Each active filter shall undergo a functional test and a full load current burn-in test at its original manufacturing plant. Equipment including a harmonic producing load, current sense CTs, and an active filter under test shall be used for the following tests:

1. A harmonic correction performance test to ensure harmonic correction and attenuation specifications are met. The unit shall be tested at greater than 80% of rated current at rated voltage.

2. A full load current burn-in test to reach thermal steady state within the unit. The test duration shall be from 1 hour to 4 hours depending on the active filter current rating. The filter shall operate at greater than 95% of rated current with at least 80% of the current comprising of harmonics.

B. A factory test report shall be available when ordered with the active filter.

3.5 DEMONSTRATION

A. Provide the services of a factory-authorized service representative of the manufacturer to provide start-up service and to demonstrate and train the Owner's personnel.

1. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

2. Train the Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventive maintenance.

3. Review data in operation and maintenance manuals with the Owner's personnel.

4. Schedule training with the Owner, through the Engineer or Engineers Representative, with at least seven day's advanced notice.

END OF SECTION 26 05 26

SECTION 26 36 23 – AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install automatic delayed transfer switches (3ADTS) with number of poles, amperage, voltage, and withstand current ratings as shown on the plans. Each automatic transfer shall consist of a mechanically held power transfer switch unit and a microprocessor controller, interconnected to provide complete automatic operation. All transfer switches and control panels shall be the product of the same manufacturer.

B. The 3ADTS shall transfer the load in delayed transition (break – before –make) mode. Transfer is accomplished with a user – defined interruption period in both directions.

C. The load disconnect time delay shall be configured to be active for all transfers or to be bypassed in the event that the voltage of all three phases of the source the load is connected to drop below 70% of nominal.

D. RELATED SECTIONS

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

2. Division 26 Section "Common Work Results for Electrical".

3. Section 26 32 13 Generator

1.2 REFRENCES

A. The automatic delayed transfer switches and accessories shall conform to the requirements of:

1. UL 1008 - Standard for Automatic Transfer Switches

2. CSA C22.2 No.178 – 1978

3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)

4. NFPA 110 - Emergency and Standby Power Systems

5. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

6. NEMA Standard ICS10-2005(formerly ICS2-447) - AC Automatic Transfer Switches

7. NEC Articles 700, 701, 702

8. International Standards Organization ISO 9001: 2008

9. IEC 60947-6-1

1.3 SUBMITTALS

A. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.

B. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.

C. Manufacturer shall provide copies of following documents to owner for review and evaluation in accordance with general requirements of Division 1 and Division 26.

1. Product data on specified product.

2. Shop drawings on specified product.

1.4 WARRANTY

A. The manufacturer shall warrant that the ATS will be free from defects in material and workmanship and will conform to the Manufacturer’s standard specifications for the ATS for a period of twenty four (24) months from date of product shipment from the manufacturer.

PART 2 - PRODUCTS

2.1 MANUFATURER

A. ASCO products have been used as the basis for design. Other manufacturers' products of equivalent quality, dimensions and operating features may be acceptable, at the Engineer's discretion, if they comply with all requirements specified or indicated in these Contract documents. The following equipment shall be provided:

1. ASCO Series 300 (3ADTS).

2. ABB Zenith

2.2 MECHANICALLY HELD TRANSFER SWITCH

A. The transfer switch unit shall be electrically operated and mechanically held. The electrical operators shall be dual-solenoid mechanisms, momentarily energized. Main operators which include over current disconnect devices will not be accepted. The switch shall be mechanically interlocked to ensure only one of two possible positions, normal or emergency.

B. The switch shall be positively locked and unaffected by momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life.

C. All main contacts shall be silver composition. Switches rated 800 amperes and above shall have segmented blow-on construction for high withstand current capability and be protected by separate arcing contacts.

D. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. A manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to manually stop the contacts at any point throughout their entire travel to inspect and service the contacts when required.

E. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.

F. Where neutral conductors must be switched, the ADTS shall be provided with fully- rated neutral transfer contacts.

G. Where neutral conductors are to be solidly connected, a neutral terminal plate with fully-rated AL-CU pressure connectors shall be provided.

2.3 CONTROLLER

A. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance.

B. The controller shall direct the operation of the transfer switch. The controller's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability, minimum maintenance, inherent serial communications capability, and the ability to communicate via the Ethernet through optional communications module

C. A single controller shall provide single and three phase capability for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to ± 1% of nominal voltage. Frequency sensing shall be accurate to ± 0.1Hz. Time delay settings shall be accurate to ± 0.5% of the full scale value of the time delay. The panel shall be capable of operating over a temperature range of -20 to + 70 degrees C, and storage from -55 to + 85 degrees C.

D. The controller shall be enclosed with a protective cover and be mounted separate from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on printed circuit boards.

E. The controller shall meet To exceed the requirements for Electromagnetic Compatibility (EMC) as follows:

1. IEC 60947 – 6 – Multiple Function Equipment Transfer Switching Equipment

2. IEC 61000-4 Testing and Measurement Techniques

a. IEC 61000 – 4 - 2 Electrostatic Discharge Immunity

b. IEC 61000 – 4 - 3 Radiated RF Field Immunity

c. IEC 61000 – 4 - 4 Electrical Fast Transient/Burst Immunity

d. IEC 61000 – 4 - 5 Surge Immunity

e. IEC 61000 – 4 – 6 Conducted RF Immunity

3. CISPR 11 – Conducted RF Emissions and Radiated RF Emissions

2.4 ENCLOSURE

A. The 3ADTS shall be furnished in a NEMA type 3R enclosure unless otherwise shown on the Drawings.

B. Provide strip heater with thermostat for Type 3R enclosure requirements.

C. Controller shall be mounted on, visible, and operational through enclosure door.

2.5 CONTROLLER DISPLAY AND KEYPAD

A. A graphical LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters.

B. Operational parameters shall also be available for viewing and limited control through communications port. The following parameters shall only be adjustable via DIP switches on the controller.

1. Nominal line voltage and frequency

2. Single or three phase sensing on normal

3. Transfer operating mode configuration, (open transition, or delayed transition)

C. All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

2.6 VOLTAGE AND FREQUENCY SENSING

A. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout, and trip settings capabilities (values shown as % of nominal unless otherwise specified.

Parameter	**Sources**	**Dropout/Trip**	**Pickup/Reset**
Undervoltage	N & E	70 to 98%	85 to 100%
Overvoltage	N & E	102 to116%	2% below trip
Underfrequency	N & E	85 to 98%	86 to 100%

Overfrequency	N & E	101 to 111%	2% below trip

B. Repetitive accuracy of all settings shall be within 1% at +25◦C.

C. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.

D. Source status screens shall be provided for both normal & emergency to provide digital readout of voltage and frequency. Note: Single phase on emergency

E. The backlit 128*64 graphical display shall have multiple language capability. Languages can be selected from the user interface.

2.7 TIME DELAYS

A. A time delay shall be provided to override momentary normal source outages and delay all transfer and engine starting signals, adjustable 0 to 6 seconds. It shall be possible to bypass the time delay from the controller user interface.

B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes 59 seconds for controlled timing of transfer of loads to emergency. It shall be possible to bypass the time delay from the controller user interface.

C. A generator stabilization time delay shall be provided after transfer to emergency adjustable 0 or 4 seconds.

D. A time delay shall be provided on retransfer to normal, adjustable 0 to 9 hours 59 minutes 59 seconds. Time delay shall be automatically bypassed if emergency source fails and normal source is acceptable.

E. A cooldown time delay shall be provided on shutdown of engine generator, adjustable 0 to 60 minutes 59 seconds.

F. All adjustable time delays shall be field adjustable without the use of special tools.

G. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minutes 59 seconds time delay in any of the following modes:

1. Prior to transfer only.

2. Prior to and after transfer.

3. Normal to emergency only.

4. Emergency to normal only.

5. Normal to emergency and emergency to normal.

6. All transfer conditions or only when both sources are available.

H. In the event that the alternate source is not accepted within the configured failure to accept time delay, the common alert shall become active.

I. The controller shall also include the following built-in time delay for delayed transition transfer operation.

1. A time delay for the load disconnect position for delayed transition operation adjustable 0 to 5 minutes 59 seconds in 1 second increments.

2.8 DISCONNECTING AND OVERCURRENT PROTECTION DEVICE

A. For those automatic transfer switches less than 1000 amperes, the normal connection shall be provided with a thermal magnetic rated molded case circuit breaker with current ratings as shown on the plans. It shall have a thermal magnetic trip unit.

B. For those automatic transfer switches rated above 1000 amperes, the normal connection shall be provided with a stationary mount, insulated case circuit breaker with a solid-state trip unit. The trip unit shall have an adjustable long time, short time, instantaneous, and ground fault trip settings. The insulated case circuit breaker shall trip open when the ground fault setting is exceeded.

C. Ampere Interrupting Capacity (AIC)

1. The maximum short circuit current the breaker shall be required to interrupt is as follows:

Switch Rating	AIC Rating	Voltage
70 – 225A	25,000A	480V
250, 400A	50,000A	480V
600A	50,000A	480V
800 – 2000A	65,000A	480V
2500, 3000A	100,000A	480V

2.9 ACCESSORIES

A. Accessory Package - An accessory bundle shall be provided that includes:

1. A fully programmable engine exerciser with seven independent routines to exercise the engine generator, with or without load on a daily weekly, bi – weekly, or monthly basis.

2. Event log display that shows event number, time and date of events, event type, and reason (if applicable). A minimum of 300 events shall be stored.

3. RS – 485 communications port enabled.

4. Common alarm output contact.

B. Controller Power Supply - A backup power UPS shall be provided to allow controller to run for 3 minutes minimum without AC power. (This feature shall be equal to ASCO accessory 1UP, and shall be capable of being added to existing switches without modification).

C. Expansion Module - A relay expansion module (REX) is a standard feature when delayed transition transfer is specified. A REX module shall also be provided for open transition transfer that includes one form C contact for source availability of the normal (18G) and emergency (18B) sources. Additional output relay shall be provided to indicate a common alarm. The REX module shall have the capability of being daisy chained for multiple sets of contacts. (This feature shall be equal to ASCO accessory 18RX, and shall be capable of being added to existing switches without modification).

D. Current Sensing Card - A load current metering card shall be provided that measures either single or three phase load current. It shall include current transformers (CT's) and shorting block. Parameters shall be able to be viewed via the user interface. (This feature shall be equal to ASCO accessory 23GA (single phase), 23GB (three phase), and shall be capable of being added to existing switches without modification).

E. Communications Module – Shall provide remote interface module to support monitoring of vendor's transfer switch, controller and optional power meter. Module shall provide status, analog parameters, event logs, equipment settings & configurations over embedded webpage and open protocol. Features shall include:

1. Email notifications and SNMP traps of selectable events and alarms may be sent to a mobile device or PC.

2. Modbus TCP/IP, SNMP, HTTP, SMTP open protocols shall be simultaneously supported.

3. Web app interface requiring user credentials to monitor and control the transfer switch supporting modern smart phones, tablets and PC browsers. User will be able to view the dynamic one-line, ATS controls status, alarms, metering, event logging as well as settings.

4. Secure access shall be provided by requiring credentials for a minimum of 3 user privilege levels to the web app, monitor (view only), control (view and control) and administrator (view, control and change settings). 128-Bit AES encryption standard shall be supported for all means of connectivity.

5. Shall allow for the initiating of transfers, retransfers, bypassing of active timers and the activating/deactivating of engine start signal shall be available over the embedded webpage and to the transfer switch vendor's monitoring equipment.

6. An event log displaying a minimum of three-hundred (300) events shall be viewable and printable from the embedded webpages and accessible from supported open protocols.

7. Four (4) 100 Mbps Ethernet copper RJ-45 ports, two (2) serial ports, and LEDs for diagnostics.

8. DIN rail mountable.

F. Transfer Alarm - An audible alarm with silencing feature shall be provided to signal each time transfer to emergency occurs. (This feature shall be equal to ASCO accessory 62W).

G. Load Shed Circuit (Contact) – A load shed shall be initiated by opening of customer supplied contact to match generator set capacity to the load. Relay de – energization opens emergency contactor (CE) disconnecting the load from the emergency source. If the normal source is acceptable, normal source contactor (CN) is closed to connecting the load to the normal source. When the load is reconnected to normal the control panel is reset in readiness for the next normal source failure. (This feature shall be equal to ASCO accessory 30AA).

H. Load Shed Circuit (Voltage) – A load shed shall be initiated by the removal of the control voltage to a relay to match generator capacity to the load. Relay de – energization opens emergency contactor (CE) disconnecting the load from emergency source. If the normal source is acceptable, normal source contactor (CN) is closed connecting the load to the normal source. When the load is reconnected to normal the control panel is reset in readiness for the next normal source failure. (This feature shall be equal to ASCO accessory 30BA*).

I. Enclosure Heater - A 125 watt enclosure heater with transformer and thermostat (adjustable from 30° to 140° F) shall be provided for outdoor installations where type 3R, 4, are specified.

J. I. Surge Suppression – A TVSS with a surge current rating of 65kA shall be provided with individually matched fused metal oxide varistors (MOVs). It shall include LED status indication of normal operation, under voltage, power loss, phase loss or component failure. Shall include form C dry contacts for external alarm or monitoring. The unit shall be enclosed in a Noryl housing rated NEMA 4, 12, and 4X. Shall comply with UL 1449 3rd edition.

PART 3 - EXECUTION

3.1 GENERAL

A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of Specification Division 26 and Drawings.

3.2 TEST AND CERTIFICATION

A. The complete 3ADTS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

B. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.

C. The ADTS manufacturer shall be certified to ISO 9001: 2008 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001: 2008.

3.3 SERVICE REPRESENTATION

A. The ADTS manufacturer shall maintain a national service organization of company- employed personnel located throughout the contiguous United States. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.

B. The manufacturer shall maintain records of switch shipments, by serial number, for a minimum of 20 years.

C. For ease of maintenance, the transfer switch nameplate shall include drawing numbers and serviceable part numbers.

END OF SECTION 26 36 23

SECTION 26 50 00 – LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Provide labor, material, equipment, related services, and supervision required, including, but not limited to installation, connections and testing of all lighting fixtures and accessories as required for the complete performance of the work, as shown on the Drawings, as specified herein.

B. RELATED SECTIONS

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

2. Division 26 Section "Common Work Results for Electrical".

1.2 REFRENCES

A. The equipment in this specification is designed and manufactured according to latest revision of the following standards (unless otherwise noted).

1. Illuminating Engineering Society of North America (IESNA)

2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)

3. Underwriters Laboratories (UL)

1.3 SUBMITTALS

A. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.

B. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.

C. Manufacturer shall provide copies of following documents to owner for review and evaluation in accordance with general requirements of Division 1 and Division 26.

1. Product data on specified product documenting the following

a. Interior lighting fixtures:

1) Catalog data sheets and pictures.

2) Fixture finish and metal gauge.

3) Lens material, pattern, and thickness.

4) Mounting or suspension details.

b. Exterior lighting fixtures:

1) Catalog data sheets and pictures.

2) Fixture finish and metal gauge.

3) Lens material, pattern, and thickness.

4) Fastening details to wall or pole.

5) Light poles, dimensions and finish

c. Lighting fixtures submitted as equal to those in the schedule without accompanying equivalent digital IES photometric data file will be rejected.

D. Provide a guarantee against defective materials and workmanship in accordance with requirements of the Section 26 05 00 of these Specifications.

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES

A. General

1. Lighting fixtures shall be furnished as described in the fixture schedule and as indicated on the Drawings. All lighting fixtures shall be LED unless noted otherwise. Lighting fixtures shall be furnished complete with lamps, ballast and/or LED drivers, and dimmers as required for proper operation.

2. Exterior light fixtures shall be UL listed for operation in wet locations.

B. Finishes

1. Light fixture shall be medium bronze unless noted otherwise on the Fixture Schedule.

2.2 LIGHTING CONTACTOR

A. Remote control lighting contactors shall be provided as indicated on the Drawings. Contactors shall have positive locking features and shall be non-combination mechanically held in both positions. Main contacts shall be double-break, continuous-duty rated 30 amperes, 600 volts ac,

for all types of loads. Contactors shall be Eaton C30CN, GE CR460, Square D Class 8903 or equal.

B. Contactor control panel shall be UL 508A listed and NEMA 12 rated for the environment unless noted otherwise. The short circuit current rating shall meet or exceed the available short circuit current indicated on the bus feeding the contactor.

C. Enclosed lighting control shall be provided with control power transformer and HOA selector switch.

D. Photoelectric controls shall be weatherproof, swivel adjustable, with built-in time delay to prevent accidental turnoff by momentary brightness. The photocell shall be rated 1800 VA, 120 volts ac, and shall be field adjustable from 1 ft/c turn-on to 15 ft/c turn-off.

E. Provide photo cells as called for in the fixture schedule or shown on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fixtures in accordance with the manufacturer's recommendation.

B. Install fixtures plumb and level.

C. Install each fixture with a junction box and any necessary supports for wire terminations.

1. Contactor is responsible for the following:
2. Provide and install mounting system, hangers, pendants, and ceiling bracing as required compatible with ceiling system shown on the Drawings.
3. Coordinate fixtures, mounting hardware, trim and accessories with ceiling system as required, including work of other trades required to be mounted on ceiling or in ceiling space.
4. The proper support and mounting of lighting fixtures in accordance with NEC Article 410 Part IV. If required, lighting fixtures shall be provided with disconnects in accordance with NEC requirements. The fixture installation shall comply with applicable local code requirements of the authority having jurisdiction and the NEC.

3.2 ADJUSTING AND CLEANING

A. Install all fuses.

B. Clean interior lighting fixtures of dirt and construction debris upon completion of installation.

C. Remove labels and markings from fixtures.

D. Clean fingerprints and smudges from lenses and lamps.

E. All lighting fixtures shall be clean at time of final acceptance.

F. Adjust aimable fixtures to provide required light intensities.

END OF SECTION 26 50 00