DIVISION 26

SECTION 260500

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This division of the Specifications, Division 26, covers the complete interior and exterior electrical systems as indicated on the drawings or as specified herein. Provide all materials, labor, equipment and supervision to install electrical systems.

1.3 QUALITY ASSURANCE

A. All electrical work shall be in accordance with the following codes and agencies:
1. The National Electrical Code (NFPA 70)
2. The National Electrical Safety Code (ANSI C-2)
3. The Life Safety Code (NFPA 101)
4. The International Building Code
5. Occupation Safety and Health Administration (OSHA)
6. Manufacturer’s written requirements.
7. Regulations of the local utility company with respect to metering and service entrance.
8. Municipal ordinances governing electrical work.

B. Material Standards: All material shall be new and shall conform to the standards where such have been established for the particular material in question. Publications and Standards of the organization listed below are applicable to materials specified herein.
1. American Society for Testing and Materials (ASTM)
2. Underwriters' Laboratories, Inc. (UL)
3. National Electrical Manufacturer Association (NEMA)
4. Insulated Cable Engineers Association (ICEA)
5. Institute of Electrical and Electronic Engineers (IEEE)
6. National Fire Protection Association (NFPA)
7. American National Standards Institute (ANSI)
8. Manufacturer’s Written Requirements

1.4 PERMITS

A. Obtain all permits and inspections for the installation of this work and pay all charges incident thereto. Deliver to the Owner all certificates of said inspection issued by authorities having jurisdiction.

1.5 WARRANTY

A. The Contractor warrants to the Owner and Engineer that materials and equipment furnished under the Contract will be of good quality and new unless otherwise required or permitted by the Contract Documents, that the Work will be free from defects not inherent in the quality required or permitted, and that the Work will conform with the requirements of the Contract Documents. Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective. The Contractor's warranty excludes remedy for damage or defect caused by abuse, modifications not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear under normal usage. If required by the Architect, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

1.6 DRAWINGS

A. The drawings indicate the arrangements of electrical equipment. Review engineering drawings for door swings, cabinets, counters and built-in equipment; conditions indicated on engineering plans shall govern. Coordinate installation of electrical equipment with site conditons.

B. Bring all discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions to the immediate attention of the Engineer.

C. Equipment layout is based on one manufacturer's product. Where equipment selected by the Contractor for use on the job differs from layout, the Contractor shall be responsible for coordinating space requirements and connection arrangements.

1.7 SUBMITTALS:

A. Shop Drawings and Product Data:
1. The Contractor shall submit for review by the Engineer data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, catalogs, cuts, diagrams, performance curves, and charts published by the manufacturer to show conformance to specification and drawing requirements; model numbers alone will not be acceptable. Provide complete electrical characteristics for all equipment.
2. Refer to the individual sections for identified equipment and materials for which submittals are required.

B. Record Documents
1. Refer to Division 01 for record documents and related submittals.

1.8 OPERATION AND MAINTENANCE DATA AND INSTRUCTIONS

A. Refer to Division 01 for detail requirements.

B. Printed Material: Provide required printed material for binding in operation and maintenance manuals.

C. Instructions of Owner Personnel:
1. Before final inspection, as designated by the Engineer provide a competent representative to instruct Owner's designated personnel in systems under this division of the specifications. For equipment requiring seasonal operation, perform instructions for other season within six months unless requested otherwise.
2. Use operation and maintenance manuals as basis of instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

3. Prepare and insert additional data in Operation and Maintenance Manual when need for such data becomes apparent during instruction.

1.9 EQUIPMENT REQUIRING ELECTRICAL SERVICE

A. Review all specification sections and drawings for equipment requiring electrical service. Provide service to and make connections to all such equipment requiring electrical service. Refer to ELECTRICAL CONNECTIONS FOR EQUIPMENT section for connection requirements.

B. Drawings indicate design loads and voltages and corresponding control equipment, feeders, and overcurrent devices. If equipment actually furnished have loads other than those indicated on the drawings or specified herein, control equipment, feeders, and overcurrent devices shall be adjusted in size accordingly at no additional cost to the Owner. Such adjustment shall be subject to the review of the Engineer.

C. Incidental items not indicated on Drawings or mentioned in Specifications but that can legitimately and reasonably be inferred to belong to the Work or be necessary in good practice to provide a complete system, shall be furnished and installed as though itemized here in detail.

1.10 SCHEDULING OF OUTAGES

A. Electrical work requiring interruption of electrical power which would adversely affect the normal operation of the other portions of the Owner's property, shall be done at time other than normal working hours. Normal working hours shall be considered eight A.M. to five P.M. Monday through Friday.

B. Schedule all work requiring interruption of electrical power two weeks prior to actual shutdown. Submit schedule in writing indicating extent of system to be de-energized, date and time when power is intended to be interrupted, and date and time power will be restored. Schedule shall be subject to the approval of the Engineer and the Representative of the Owner.

1.11 SITE INVESTIGATION

A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions which may affect the cost of the project. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems, shall be restored to their original condition, with the exception of the work under this contract, before the completion of this project.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials shall be new.

B. Furnish all materials specified herein or indicated on the drawings.

C. Materials of the same type shall be the product of one manufacturer.

D. All materials shall be UL listed and shall bear UL label. ETL listed material shall bear ETL label. ETL label shall be accepted in lieu of UL when the UL testing standards have been followed.

PART 3 - EXECUTION

3.1 PRODUCT DELIVERY, STORAGE, HANDLING, AND PROTECTION

A. Inspect materials upon arrival at Project and verify conformance to Contract Documents. Prevent unloading of unsatisfactory material. Handle materials in accordance with manufacturer's applicable standards and suppliers recommendations, and in a manner to prevent damage to materials. Store packaged materials in original undamaged condition with manufacturer's labels and seals intact. Containers which are broken, opened, damaged, or watermarked are unacceptable and shall be removed from the premises.

B. All material, except items specifically designed to be installed outdoors such as pad mounted transformers or stand-by generators, shall be stored in an enclosed, dry building or trailer. Areas for general storage shall be provided by the Contractor. Provide temperature and/or humidity control where applicable. No material for installation, including conductors, shall be stored other than in an enclosed weathertight structure. Equipment stored other than as specified above shall be removed from the premises.

C. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable to protect the equipment or materials. Conditions shall be those for which the equipment or materials are designed to be installed. Equipment and materials shall be protected from water, direct sunlight, cold or heat and high humidity at all times. Equipment or materials damaged or which are subjected to these elements are unacceptable and shall be removed from the premises and replaced.

3.2 CLEANING AND PAINTING

A. Remove oil, dirt, grease and foreign materials from all raceways, fittings, boxes, panelboard trims and cabinets to provide a clean surface for painting. Touchup scratched or marred surfaces of panelboard and cabinet trims, switchboard or equipment enclosures with paint furnished by the equipment manufacturers specifically for that purpose.

B. Unless indicated on the drawings or specified herein to the contrary, all painting shall be done under the PAINTING Section of these Specifications.

3.3 EXCAVATION, TRENCHING AND BACKFILLING

A. Perform all excavation to install conduits, indicated on the drawings or specified herein. During excavation, pile material for backfilling back from the banks of the trench to avoid overloading and to prevent slides and cave-ins. Provide shoring as required by OSHA Standards. Remove and dispose of all excavated materials not to be used for backfill. Grade to prevent surface water from flowing into trenches and excavation. Remove any water accumulating therein by pumping. Do all excavation by open cut. No tunneling shall be done unless indicated on the drawings or unless written permission is received from the Architect.

B. Grade the bottom of trenches to provide uniform bearing and support for conduits on undisturbed soil at every point along its entire length. Tamp overdepths with loose, granular, moist earth. Remove unstable soil that is not capable of supporting equipment or installation and replace with specified material for a minimum of 12" below invert of equipment or installation.

C. Backfill the trenches with excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel or soft shale, free from large clods of earth and stones, deposited in 6" layers and rammed until the installation has a cover of not less than the adjacent ground but not greater than 2"

above existing ground. Backfilling shall be carried on simultaneously on both sides of the trench so that injurious pressures do not occur. Compaction of the filled trench shall be at least equal to that of the surrounding undisturbed material. Do not settle backfill with water. Reopen any trenches not meeting compaction requirements or where settlement occurs, refill, compact, and restore surface to grade and compaction indicated on the drawings, mounded over and smoothed off.

3.4 ELECTRICAL SYSTEMS OPERATIONAL TESTS, MANUFACTURERS SYSTEMS CERTIFICATION AND DESIGN AUTHORITY ASSISTANCE.

A. Testing
   1. Refer to the individual specification sections and the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of the specifications for test requirements.
   2. Prior to the final inspection, the systems or equipment shall be tested and reported as therein specified. Five (5) typewritten copies of the tests shall be submitted to the Engineer for approval.
   3. All electrical systems shall be tested for compliance with the specifications.

B. Manufacturers Certifications
   1. The electrical systems specified herein shall be reviewed for compliance with these specifications, installation in accordance with the manufacturers recommendations and system operation by a representative of the manufacturer. The manufacturer shall submit certification that the system has been reviewed by the manufacturer is installed in accordance with the manufacturer's recommendations and is operating in accordance with the specifications.
   2. Provide manufacturers certification for the following systems:
      a. Engine Driven EPSS

C. Design Authority Assistance
   1. The Contractor shall provide personnel to assist the Engineer or his representative during all construction review visits. The Contractor shall provide all necessary tools and equipment to demonstrate the system operation and provide access to equipment, including screwdrivers, wrenches, ladders, flashlights, circuit testing devices, meters, keys, radios, etc.
   2. Remove equipment covers (i.e. panelboard trims, motor controls, device plates, and junction box covers) as directed for inspection of internal wiring. Accessible ceilings shall be removed as directed for inspection of equipment installed above ceilings.
   3. Energize and de-energize circuits and equipment as directed. Demonstrate operation of equipment and systems as directed by the Representative.
   4. The Contractor shall provide authorized representatives of the manufacturers to demonstrate to the Engineer compliance with the specifications of their respective system during or prior to the final inspection at a time designated by the Engineer. Refer to the specific specification section for additional testing requirements. Representatives of the following systems are required for demonstrations:
      a. Engine Driven EPSS

END OF SECTION

SECTION 260519

WIRES AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The work required under this section of the specifications consists of furnishing, installation and connections of the building wiring system, 600 volts and below. Exterior branch circuit wiring and feeder conductors extended beyond the building are included. Wiring systems for communication and alarm systems are not included in this division unless specified to be included, by reference, in the respective divisions for alarm and communication systems.

1.3 QUALITY ASSURANCE

A. Industry Referenced Standards. The following specifications and standards are incorporated into and become a part of this Specification by Reference.
   1. Underwriters' Laboratories, Inc. (UL) Publications:
      a. No. 44: Rubber - Insulated Wire and Cables
      b. No. 83: Thermoplastic - Insulated Wires
      c. No. 493: Thermoplastic - Insulated Underground Feeder and Branch Circuit Cables
      d. No. 486: Wire Connectors and Soldering Lugs
   2. Insulated Cable Engineers Association Standards (ICEA):
      a. S-61-402: Thermoplastic Insulated Wire and Cable
   3. National Electrical Manufacturer's Standards (NEMA):
      a. WC-5: Thermoplastic Insulated Wire and Cable
   4. National Fire Protection Association Publication (NFPA):
      a. No. 70: National Electrical Code (NEC)
   5. Federal Specifications (Fed. Spec.):
      a. J-C-30A(1) Cable and Wire Electrical (Power Fixed Installations)
      b. HH-I-595C: Insulation Type, Electrical, Pressure-Sensitive Adhesive, Plastic

B. Acceptable Manufacturers. Products produced by the following manufacturers which conform to this specification are acceptable.
   1. Hydraulically applied conductor terminations:
      a. Square D
      b. Burndy
      c. Ilsco
      d. Scotch (3M)
      e. Thomas and Betts (T&B)
      f. Anderson
   2. Mechanically applied (crimp) conductor terminations:
      a. Scotch (3M)
      b. Ideal

c. Thomas and Betts (T&B)
d. Burndy

3. Vinyl electrical insulating tape:
   a. Scotch (3M)
   b. Tomic
   c. Permacel
4. Twist-On Wire Connectors:
   a. Scotch (3M)
   b. Ideal
   c. Buchanan
5. Encapsulated insulating kits:
   a. Scotch (3M)
   b. Raychem
   c. Essex Group, Inc.
6. Portable cable fittings:
   a. Crouse Hinds
   b. Appleton
   c. T&B
7. Insulated cable:
   a. Brand-Rex Co.
   b. Cablec Corp.
   c. The Okonite Co.
   d. Pirelli Cable Corp.
   e. Senator Wire and Cable Co.
   f. Southwire Co.
   g. Houston Wire & Cable Co.
   h. Aetna Insulated Wire Co.
   i. American Insulated Wire Corp.

C. Performance: Conductors shall be electrically continuous and free from short circuits or grounds. All open, shorted or grounded conductors and any with damaged insulation shall be removed and replaced with new material free from defects.

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS REQUIREMENTS

A. Provide all materials under this section of the specifications.

B. All wire and cable shall be UL listed and shall bear a UL label along the conductor length at intervals not exceeding 24 inches.

C. All conductors shall have size, grade of insulation, voltage and manufacturer's name permanently marked on the outer cover at intervals not exceeding 24 inches.

D. Conductor size shall be a minimum of No. 12 AWG. Conductor size shall not be less than indicated on the drawings. The minimum size of emergency systems conductors shall be No. 10 AWG.

E. Insulation voltage level rating shall be 600 volts.

2.2 PRODUCT/MATERIALS DESCRIPTION

A. Conductors No. 10 AWG and smaller shall be solid copper, 90°C type THHN/THWN or XHHN, unless otherwise indicated on the drawings, required by the National Electrical Code or specified elsewhere in Division 26.

B. Conductors larger than No. 10 AWG shall be stranded copper, 90°C,, type THHN/THWN, XHHW, unless otherwise indicated on the drawings, required by the National Electrical Code, or specified herein.

C. Control conductors for use on 120 volt control wiring systems shall be No. 12 AWG stranded type THHN/THWN, unless indicated otherwise on the drawings.

D. Splices and taps (No. 10 AWG and smaller) - Connectors for solid conductors shall be solderless, screw-on, spring pressure cable type, 600 volt, 105°C. with integral insulation and UL approved for aluminum and copper conductors. Connectors for stranded conductors shall be crimp-on type with integral insulating cover.

E. Splices and taps (No. 8 and larger) - Hydraulically applied crimping sleeve or tap connector sized for the conductors. Insulate the hydraulically applied connector with 90°C., 600 volt insulating cover provided by the connector manufacturer. Insulator materials and installation shall be approved for the specific application, location, voltage and temperature and shall not have an insulation value less than the conductors being joined.

F. Electrical insulating tape shall be 600 volt, flame retardant, cold and weather resistant, minimally .85 mil thick plastic vinyl material; Scotch No. 88, Tomic No. 85, Permacel No. 295.

PART 3 - EXECUTION

3.1 EXECUTION

A. Install all wiring in raceway system.

B. Connect all conductors. Torque each terminal connection to the manufacturers recommended torque value. A calibrated torqueing tool shall be used to insure proper torque application. Any conductors nicked or ringed while removing insulation shall be replaced.

C. Do not install more conductors in a raceway than indicated on the drawings. A maximum of three branch circuits are to be installed in any one conduit, on 3 phase 4 wire system, unless specifically indicated otherwise on the drawings. No two branch circuits of the same phase are to be installed in the same conduit, unless specifically indicated on the drawings.

D. Conductors shall be tested to be continuous and free of short circuits and grounds.

E. Identification
   1. Conductors within pull boxes shall be grouped and identified with nylon tie straps with circuit identification tag.
   2. Identify each control conductor at its terminal points with wrap around tape wire markers. I.D. to indicate terminal block and point designation, or other appropriate identifying indication.
   3. Refer to ELECTRICAL IDENTIFICATION section of these specifications for additional identification requirements.

F. Color Code Conductors.
   1. Color code all secondary service, feeder and branch circuit conductors. Control and signal system conductors need not be color coded.
   2. Coding shall be as follows:
      a. 480Y/277 volt three phase four wire system - Phase A: Brown, Phase B: Orange, Phase C: Yellow, Neutral: Gray
      b. 240/120 volt single phase 3 wire system - Phase A: Black, Phase B: Red, and Neutral: White
      c. 240/120V three phase, 4 wire Delta system – Phase A: Black, Phase B (High Leg): Orange, Phase C: Red, and Neutral: White
   3. Grounding conductors shall be green.
   4. Conductors No. 6 and smaller shall have solid color compound insulation or continuous color finish. Conductors No. 4 and larger shall have colored phase tape. Colored tape shall be installed on conductors in every box, at each terminal point, cabinet, through manhole or other enclosure.

G. Maintain phase rotation established at service equipment throughout entire project.

H. Group and lace with nylon tie straps all conductors within enclosures, i.e. panels, switchboard, switchgear.

I. Make splices in conductors only within junction boxes. Do not splice conductors in pull boxes, panelboards, switchboard, switchgear, wiring troughs or motor control enclosures.

J. Support conductors installed in vertical raceways at intervals not exceeding those distances indicated in the National Electrical Code. Support conductors in pull boxes with bakelite wedge type supports provided for the size and number of conductors in the raceway. wood blocking is not acceptable. Do not splice conductors in pull boxes used for vertical cable supports unless written permission for splicing is obtained. Where splicing is permitted, make splice with hydraulically applied splicing sleeve.

K. Terminate conductors No. 10 AWG and smaller specified in Division 26 to be stranded, with crimp type lug or stud. Direct termination of stranded conductors without crimp terminator to terminal screws, lugs, or other points is not permitted even if terminal is rated for stranded conductors. Crimp terminal shall be the configuration type suitable for terminal point. Crimp lugs shall be applied in strict accordance with the manufacturer’s written requirements.

L. Control, communications or signal conductors shall be installed in separate raceway systems from branch circuit or feeder raceway, unless indicated otherwise on the drawings.

M. Splices in conductors installed below grade are not permitted.

END OF SECTION

SECTION 260526

SECONDARY GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The work required under this section of the specifications consists of furnishing, installation and connections of the building secondary grounding systems. Exterior branch circuit wiring and feeder conductors extended beyond the building are included. The building electrical system shall be a 3 phase, 4 wire grounded wye system supplemented with equipment grounding system. Equipment grounding system shall be established with equipment grounding conductors; the use of metallic raceways for equipment grounding is not acceptable.

1.3 QUALITY ASSURANCE

A. Industry Referenced Standards. The following specifications and standards are incorporated into and become a part of this Specification by Reference.
   1. Underwriters' Laboratories, Inc. (UL) Publications:
      a. No. 44: Rubber - Insulated Wire and Cables
      b. No. 83: Thermoplastic - Insulated Wires
      c. No. 467: Electrical Grounding and Bonding Equipment
      d. No. 493: Thermoplastic - Insulated Underground Feeder and Branch Circuit Cables
      e. No. 486: Wire Connectors and Soldering Lugs
   2. National Electrical Manufacturer's Standards (NEMA):
      a. WC-5: Thermoplastic Insulated Wire and Cable
      b. WC-7: Cross-Linked-Thermosetting Polyethylene Insulated Wire and Cable
   3. National Fire Protection Association Publication (NFPA):
      a. No. 70: National Electrical Code (NEC)

B. Acceptable Manufacturers. Products produced by the following manufacturer which conform to this specification are acceptable.
   1. Hydraulically applied conductor terminations:
      a. Square D
      b. Burndy
      c. Ilsco
      d. Scotch (3M)
      e. Thomas and Betts (T & B)
      f. Anderson
   2. Mechanically applied (crimp) conductor terminations:
      a. Scotch (3M)
      b. Ideal
      c. Thomas and Betts (T & B)
      d. Burndy

3. Exothermic connections:
   a. Cadweld

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS REQUIREMENTS

A. Provide all materials under this section of the specifications. All materials shall be new.

B. All materials shall be UL listed and bear a UL label.

C. Refer to the specific specification section for the description and requirements of materials mentioned herein for installation.

2.2 GROUNDING CONDUCTORS

A. Grounding electrode conductor shall be bare or green insulated copper conductor sized as indicated on the drawings.

B. Equipment grounding conductors shall be green insulated type THW, THWN, or XHHN conductors sized as indicated on the drawings. Where size is not indicated on the drawings, conductor size shall be determined from the National Electrical Code table on sizes of equipment grounding conductors.

C. Bonding jumpers shall be flexible copper bonding jumpers sized in accordance with the National Electrical Code tables for grounding electrode conductors.

2.3 TRANSFORMERS, MOTOR CONTROLLERS, AND DISCONNECT SWITCHES

A. Provide a conductor termination grounding lug bonded to the enclosure of each equipment item.

2.4 DEVICES

A. Each receptacle and switch device shall be furnished with a grounding screw connected to the metallic device frame.

2.5 GROUND RODS

A. Ground rods shall be 3/4" x 10'-0" copper clad steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Ground all non-current carrying parts of the electrical system, i.e., wireways, equipment enclosures and frames, junction and outlet boxes, machine frames and other conductive items in close proximity with electrical circuits, to provide a low impedance path for potential grounded faults.

B. Service entrance and separately derived electrical systems, grounding electrode system.

1. The neutral conductor of the electrical service serving the premises wiring system shall be grounded to the ground bus bar in the service equipment which shall be grounded to the cold water system, the ground rod system, and other grounding electrodes specified herein or indicated on the drawings. Grounding electrode conductors shall be installed in rigid, non-metallic conduit to point of ground connection, unless subject to physical damage in which case they shall be installed in galvanized rigid steel. Where metallic conduit is permitted, bond conduit at both ends to grounding electrode conductor with a UL bonding bushing.
2. Make connection to main water line entering the building. Make connections ahead of any valve or fittings whose removal may interrupt ground continuity. Install a bonding jumper of the same size as the grounding conductor around the water meter.
3. Bond together the following systems to form the grounding electrode system. All system connections shall be made as close as possible to the service entrance equipment and each connected at the service entrance equipment ground bus. Do not connect electrode systems together except at ground bus.
   a. Cold water piping system
   b. Ground rod system
   c. Main rebar in a foundation footing, for a concrete structure
4. Ground the neutral of all dry type transformers to the service grounding system.
5. Ground the neutral and frame of the emergency generator to the ground rod system, which shall serve as the grounding electrode for the separately derived system.
6. Grounding electrode connections to structural steel, reinforcing bars, ground rods, or where indicated on the drawings shall be with chemical exothermic weld connection devices recommended for the particular connection type. Connections to piping shall be with UL listed mechanical ground clamps.
7. Bonding shall be in accordance with the National Electrical Code.
8. Install ground rods where indicated on the drawings with the top of the ground rods 12" below finished grade.

C. Equipment Grounding Conductor
1. Grounding conductors for branch circuits are not shown on the drawings; however, grounding conductors shall be provided in all branch circuit raceways and cables. Grounding conductors shall be the same AWG size as branch circuit conductors.
2. Grounding conductors for feeders are typically indicated on the drawings and the raceway is sized to accommodate grounding conductor shown. Where grounding conductor size is not indicated on the drawings, conductor shall be in accordance with the equipment grounding conductor table of the National Electrical Code.
3. A grounding conductor shall be installed in all flexible conduit installations. For branch circuits, grounding conductor shall be sized to match branch circuit conductors.
4. The equipment grounding conductor shall be attached to equipment with bolt or sheet metal screw used for no other purpose. Where grounding conductor is stranded, attachment shall be made with lug attached to grounding conductor with crimping tool.
5. Equipment grounding conductors shall terminate on panelboard, switchboard, or motor control center grounding bus only. Do not terminate on neutral bus. Provide a single terminals lug for each conductor. Conductor shall terminate in the same section as the phase conductors originate. Do not terminate neutral conductors on the ground bus.

3.2 TESTING

A. Upon completion of the ground rod installation, the Contractor shall test the installation in accordance with the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification. Grounding resistance reading shall be taken before connection is made to the building cold water piping system. Ground resistance readings shall not be taken within forty-eight hours of rainfall. Results of ground resistance readings shall be forwarded, in writing, immediately to the Architect.

END OF SECTION

SECTION 260529

SUPPORTING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Extent of supports, anchors, sleeves and seals is indicated by drawings and schedules and/or specified in other Division - 26 sections.

B. Types of supports, anchors, sleeves and seals specified in this section include the following:
1. Clevis hangers.
2. Riser clamps.
3. C-clamps.
4. I-beam clamps.
5. One-hole conduit straps.
6. Two-hole conduit straps.
7. Round steel rods.
8. Expansion anchors.
9. Toggle bolts.
10. Wall and floor seals.

C. Supports, anchors, sleeves and seals furnished as part of factory-fabricated equipment are specified as part of that equipment assembly in other Division - 26 sections.

1.3 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC requirements as applicable to construction and installation of electrical supporting devices.

B. NECA Compliance: Comply with National Electrical Contractors Association's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.

C. UL Compliance: Provide electrical components which are UL-listed and labeled.

D. FS Compliance: Comply with Federal Specification FF-S-760 pertaining to retaining straps for conduit, pipe and cable.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's data on supporting devices including catalog cuts, specifications, and installation instructions, for each type of support, anchor, sleeve and seal.

B. Shop Drawings: Submit dimensioned drawings of fabricated products, indicating details of fabrication and materials.

PART 2 - PRODUCTS

2.1 MANUFACTURED SUPPORTING DEVICES

A. General: Provide supporting devices which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation; and as herein specified. Where more than one type of supporting device meets indicated requirements, selection is Installer's option.

B. Supports: Provide supporting devices of types, sizes and materials indicated; and having the following construction features:
1. Clevis Hangers: For supporting 2" rigid metal conduit; galvanized steel; with 1/2" diameter hole for round steel rod; approximately 54 lbs. per 100 units.
2. Riser Clamps: For supporting 5" rigid metal conduit; black steel; with 2 bolts and nuts, and 4" ears; approximately 510 lbs. per 100 units.
3. Reducing Couplings: Steel rod reducing coupling, 1/2" x 5/8"; black steel; approximately 16 lbs. per 100 units.
4. C-Clamps: Black malleable iron; 1/2" rod size; approximately 70 lbs. per 100 units.
5. I-Beam Clamps: Black steel, 1-1/4" x 3/16" stock; 3/8" cross bolt; flange width 2"; approximately 52 lbs. per 100 units.
6. One-Hole Conduit Straps: For supporting 3/4" rigid metal conduit; galvanized steel; approximately 7 lbs. per 100 units.
7. Two-Hole Conduit Straps: For supporting 3/4" rigid metal conduit, galvanized steel; 3/4" strap width; and 2-1/8" between center of screw holes.
8. Hexagon Nuts: For 1/2" rod size; galvanized steel; approximately 4 lbs. per 100 units.
9. Round Steel Rod: Black steel; 1/2" diameter; approximately 67 lbs. per 100 feet.
10. Offset Conduit Clamps: For supporting 2" rigid metal conduit; black steel; approximately 200 lbs. per 100 units.

C. Anchors: Provide anchors of types, sizes and materials indicated, with the following construction features:
1. Toggle Bolts: Springhead; 3/16" x 4"; approximately 5 lbs. per 100 units.
2. Expansion sleeve anchors by Hilti or Phillips Redhead: 1/2"; approximately 38 lbs. per 100 units.
3. Manufacturers: Subject to compliance with requirements, provide anchors of one of the following:
    a. Ackerman Johnson Fastening Systems Inc.
    b. Hilti
    c. Ideal Industries, Inc.
    d. Joslyn Mfg and Supply Company
    e. McGraw Edison Company
    f. Phillips Redhead
    g. Rawlplug Company Inc.

D. Sleeves and Seals: Provide sleeves and seals, of types, sizes and materials indicated, with the following construction features:
1. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sizes indicated; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.

E. Conduit Cable Supports: Provide cable supports with insulating wedging plug for non-armored type electrical cables in risers; construct for 2" rigid metal conduit; 3-wires, type wire as indicated; construct body of malleable-iron casting with hot-dip galvanized finish.

F. U-Channel Strut Systems:
1. Provide U-channel strut system for supporting electrical equipment, 12-gage hot-dip galvanized steel, of types and sizes indicated; construct with 9/16" diameter holes, 8" o.c. on top surface, with standard green finish, and with the following fittings which mate and match with U-channel.
   a. Fixture hangers.
   b. Channel hangers.
   c. End caps.
   d. Beam clamps.
   e. Wiring studs.
   f. Thinwall conduit clamps.
   g. Rigid conduit clamps.
   h. Conduit hangers.
   i. U-bolts.
2. Manufacturers: Subject to compliance with requirements, provide channel systems of one of the following:
   a. Allied Tube and Conduit Corporation.
   b. B-Line Systems, Inc.
   c. Elcen Metal Products Company.
   d. Greenfield Mfg Company, Inc.
   e. Midland-Ross Corporation.
   f. OZ/Gedney Div; General Signal Corporation.
   g. Power-Strut Div; Van Huffel Tube Corporation.
   h. Unistrut Div; GTE Products Corporation.

2.2 FABRICATED SUPPORTING DEVICES

A. Pipe Sleeves: Provide pipe sleeves of one of the following:
1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal: 3" and smaller, 20-gage; 4" to 6", 16-gage; over 6", 14" gage.
2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
3. Iron Pipe: Fabricate from cast-iron or ductile-iron pipe.
4. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

B. Sleeve Seals: Provide modular mechanical type seals, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 - EXECUTION

3.1 INSTALLATION OF SUPPORTING DEVICES

A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.

B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

C. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports in compliance with NEC requirements.

D. Torque sleeve seal nuts, complying with manufacturer's recommended values. Ensure that sealing grommets expand to form watertight seal.

E. Remove burrs from ends of pipe sleeves.

END OF SECTION

SECTION 260533

RACEWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section covers the complete interior [and exterior] raceway system.

B. Definition: The term conduit, as used in this Specification, shall mean any or all of the raceway types specified.

1.3 QUALITY ASSURANCE

A. Referenced Industry Standard: The following specifications and standards are incorporated into and become a part of this Specification by reference.
1. Underwriters' Laboratories, Inc. (UL) Publications:
   No. 1 Flexible Metal Electrical Conduit
   No. 467 Electrical Grounding and Bonding
   No. 651 Rigid Nonmetallic Electrical Conduit
   No. 797 Electrical Metallic Tubing
2. American National Standards Institute (ANSI):
   C-80.3 Electrical Metallic Tubing.
3. National Fire Protection Association (NFPA):
   No. 70 National Electrical Code (NEC).
4. Federal Specifications (Fed Spec):
   a. WW-C-540A: Conduit, Metal, Rigid (Electrical Aluminum).
   b. W-C-1094A: Conduit and Conduit Fittings Plastic, Rigid.

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable.
1. Metallic Conduit Fittings:
   a. Appleton
   b. Carlon
   c. Crouse Hinds
   d. Killark
   e. O-Z/Gedney
   f. RACO
   g. Thomas and Betts
2. Support Channel:
   a. Kindorf
   b. Powers
   c. Unistrut
3. Non-Metallic Conduit and Fittings:
   a. Carlon

b. Certainteed
c. Thomas and Betts

C. Coordination
1. Coordinate conduit installation with electrical equipment furnished.
2. Coordinate conduit installation with contract documents and other contractors. Adjust installation to eliminate conflicts. Review all shop drawings submitted under this and other sections to insure coordination with all equipment requiring electrical service and to avoid conflict interferences. Coordinate installation sequence with other contractors to avoid conflicts including equipment access and provide the fastest overall installation schedule.

1.4 STORAGE AND HANDLING

A. Refer to the BASIC ELECTRICAL REQUIREMENTS section of the specifications for storage and handling requirements.

B. Non-metallic conduits stored on site prior to installation shall be stored on a surface off of the ground and shall be protected from the direct rays of the sun and from debris.

C. Damaged, oxidized, warped, improperly stored material or material with excessive amounts of foreign debris will be removed from the project and replaced with new materials.

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS REQUIREMENTS

A. Furnish all materials specified herein.

B. All conduit and fittings shall be listed and bear a label by Underwriters' Laboratories (UL) for use as raceway system for electrical conductors.

C. Raceway is required for all wiring, unless specifically indicated or specified otherwise.

D. Size: The minimum size of conduit shall be ¾". The size of all conduits shall be in accordance with the NEC, but, not less than indicated on the drawings.

2.2 EMT CONDUIT FITTINGS

A. Electrical Metallic Tubing (EMT) couplings and connectors shall be steel "concretetight" type. Malleable iron, die cast or pressure cast fittings are not permitted. Fittings 2.0" and smaller shall be gland and ring compression type. Connectors for conduits 2.5" and larger shall be set screw type with two (2) screws each or compression type. Couplings for conduits 2.5" and larger shall be set screw type with four (4) screws each or compression type. All connectors shall be insulated throat type. All set screw connectors encased in walls or floor shall be taped at all joints.

2.3 NON-METALLIC CONDUIT AND FITTINGS

A. Non-metallic conduit shall be schedule 80 PVC.

B. Non-metallic conduit fittings shall be of the same material as the conduit furnished and be the product of the same manufacturer.

C. Glue for all non-metallic conduit and fittings shall be provided as required by the manufacturer of the conduit being used.

2.4 CONDUIT SUPPORTS

A. All parts and hardware shall be 304 stainless or have equivalent corrosion protection.

B. Conduit straps shall be two part stainless steel pipe clamp type.

C. Conduit support channels shall be 1.5" x 1.5" x 14 gauge 304 stainless steel channel. Channel suspension shall be 3/8" threaded stainless steel rods. Use swivel type connector to attach suspension rods to structure. Spring steel clips are not acceptable. Wire or chain is not acceptable for conduit hangers.

D. Individual conduit hangers shall be 304 stainless steel specifically designed for the purpose, sized appropriately for the conduit type and diameter, and have pre-assembled closure bolt and nut and provisions for receiving threaded hanger rod. Support with 1/4" threaded steel rod for individual conduits 1.5" and smaller and 3/8" rod for individual conduits 2.0" and larger.

E. Refer to SUPPORTING DEVICES section of these specifications for additional material requirements.

2.5 FLEXIBLE CONDUIT AND FITTINGS

A. Flexible conduit shall be steel metallic type. Where specified herein, indicated on the drawings, or when used in damp or wet locations, as classified by the National Electrical Code, flexible conduit shall be liquid tight.

B. All flexible conduit shall be classified as suitable for system grounding. All flexible (liquid tight) conduits shall be UL listed as sunlight (UV) resistant.

C. Connectors for flexible conduit shall be steel insulated throat type rated as suitable for system ground continuity. Connectors for liquid tight flexible conduit shall be screw-in ground cone type.

D. Flexible conduit shall not be less than ¾” trade size and in no case shall flexible conduit size be less than permitted by the National Electrical Code for the number and size of conductors to be installed herein.

2.6 MISCELLANEOUS CONDUIT FITTINGS AND ACCESSORIES

A. Vinyl all weather electrical tape for corrosion protection shall be Scotch #88, Tomic #85, Permacel #295.

B. Expansion and deflection couplings shall be in accordance with UL 467 and UL 514. They shall accommodate 3/4" deflection, expansion, or contraction in any direction and shall allow 30 degree angular deflections. Couplings shall contain an internal flexible metal braid to maintain raceway system ground continuity.

C. Fire and smoke stop materials shall be rock wool fiber, silicone foam, or silicone sealant, UL rated to maintain the fire floor or fire wall partition rating.

2.7 RIGID ALUMINUM CONDUIT FITTINGS

A. Rigid aluminum conduit fittings shall be standard threaded couplings, threaded hubs, bushings, and elbows. Material shall be compatible with aluminum conduit of malleable iron, steel or aluminum alloy. Iron or steel fittings shall be zinc or cadmium plated. Aluminum fittings shall not contain more than 0.4 percent copper. Locknuts and bushings shall be as specified for rigid steel and IMC conduit. Set screw fittings or no-thread fittings are not acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General
1. Leave all empty conduits with a 200 pound test nylon cord pull line.
2. Install as complete raceway runs prior to installation of cables or wires.
3. Flattened, dented, burned, or deformed conduits are not permitted and shall be removed and replaced.
4. Secure aluminum rigid conduit to sheet metal enclosures with threaded hubs. Secure EMT to sheet metal enclosures with insulated throat connectors with lock nut..
5. Fasten conduit support device to structure with wood screws on wood, toggle bolts on hollow masonry, anchors as specified on solid masonry or concrete, and machine bolts, clamps, or spring steel clips, on metal studs. Nails are not acceptable.
6. Protect conduits against dirt, plaster, and foreign debris with conduit plugs. Plugs shall remain in place until all masonry is complete. Protect conduit stub-ups during construction from damage; any damaged conduits shall not be used.
7. Seal all conduits originating from outside building from below grade and all conduits entering exterior mounted electrical equipment with insulating electrical putty to prevent entrance of moisture. Spray foam is not acceptable.
8. Install conduit with wiring, including homeruns as indicated on the drawings. Any change resulting in a savings in labor or materials is to be made only in accordance with a contract change. Deviations shall be made only where necessary to avoid interferences and when approved by Engineer by written authorization.
9. Use flexible conduit for connection to vibrating equipment and rotating machinery.
10. Separate raceway systems are to be installed for power systems and for control, signal and communications systems. Do not install control, signal or communications cables in the same raceways as branch circuit or feeder cables, unless indicated otherwise on the drawings.
11. Provide expansion fitting in all conduits where length of run exceeds 200 feet or where conduits pass building expansion joints.

B. Uses Permitted
1. Where transition is made from raceway in slab to any type of raceway out of slab, make transition with aluminum rigid elbow. For corrosion protection, where elbow penetrates surface, wrap with vinyl all-weather electrical tape or coat with bituminous asphaltic compound, for 6" above and below concrete surface.
2. Conduits installed in direct contact with earth shall be schedule 80, heavy wall PVC.
3. All other conduit, unless excluded herein, not permitted in accordance with the National Electrical Code, or otherwise indicated on the drawings, shall be electrical metallic tubing (EMT).
4. Conduit types shall not be mixed indiscriminately with other types in the same run, unless specified herein or required by the NEC.

5. Use flexible conduit for connections to motors and dry type transformers.
   a. Flexible conduit used for connection of motors and dry type transformers shall not exceed 18" in length.
   b. Maintain ground continuity through flexible conduit with green equipment grounding conductor; do not use flexible conduit for ground continuity.
   c. Liquid tight conduit shall be used to connect equipment in exterior installations.
6. Service entrance and feeder conduits installed exposed shall be aluminum rigid conduit (ARC). Service entrance conduits shall be installed "outside" of the building as defined by the NEC.
7. Rigid aluminum conduit shall be used for all trade sizes and larger for conduits not installed in concrete slabs, not installed in direct contact with earth.

C. Below Grade Raceway Installations
1. Direct Burial Conduit
   a. Install top of conduits 24" minimum below finished grade. Maximum depth shall be 36".
   b. Install top of conduits 6" minimum below bottom of building slabs.
   c. Install top of conduits 30" minimum below grade, below roads and any other paved surfaces.
   d. Where transition is made from below grade PVC installation to a metallic conduit system above grade or slab, make transition with rigid galvanized elbow and extend through slab or above grade with galvanized rigid steel conduit. For corrosion protection, where the elbow penetrates surface, wrap with vinyl all-weather electrical tape or coat with bituminous asphaltic compound, for 6" above and below concrete surface.
   e. For excavation and backfilling, refer to earthwork specification section.
   f. Conduit shall be run following the most direct route between points.

D. Concealed (Above Ceilings and in Walls) and Exposed Raceway Installation
1. Conduit shall be run parallel or at right angles to existing walls, ceilings, and structural members.
2. Support branch circuit conduits at intervals not exceeding 10 ft. and within three feet of each outlet, junction box, cabinet or fitting. Attach individual branch circuit conduits to structural steel members with beam conduit clamps and to non-metallic structural members with one hole conduit straps. For exposed conduits and where conduits must be suspended below structure, single conduit runs shall be supported from structure by hangar rod and conduit clamp assembly. Multiple conduits shall be supported by trapeze type support suspended from structure. Do not attach conduits to ceiling suspension system channels or suspension wires.
3. Attach feeder conduits larger than 1" trade diameter to or from structure on intervals not exceeding 12 ft. with conduit beam clamps, one hole conduit straps or trapeze type support in accordance with support systems described for branch circuit conduits.
4. Conduits rigidly secured to building construction on opposite sides of a building expansion joint shall be provided with an expansion and deflection coupling. In lieu of an expansion coupling, conduits 2-1/2" and smaller may be provided with junction boxes on both sides of the expansion joint connected by 15" of slack flexible conduit with bonding jumper.

3.2 ADJUSTMENT, CLEANING AND PROTECTION

A. Clean: Upon completion, clean all installed materials of paint, dirt, and construction debris. All conduit systems shall be cleaned of water and debris prior to the installation of any conductors.

3.3 REUSE OF EXISTING CONDUITS

A. Where existing conduits are specified to be re-used, each conduit shall be cleaned prior to the installation of conductors or cables. A standard flexible mandrel with a diameter approximately 1/4" less than the inside diameter of the conduit shall be pulled through and then a brush with soft bristles which has a diameter equal to the inside diameter of the conduit.

B. All conduit fittings shall be checked for tightness and retightened, if necessary, and all supports verified and adjusted.

END OF SECTION

SECTION 260533.01

BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The work required under this section of the specifications consists of the installation of outlet boxes, pull boxes, and junction boxes throughout the wiring system including box supports.

B. Definition: Box, as used in this specification, includes all outlet, device, junction, and pull boxes. Feeder shall mean all conductor circuits larger than #8 AWG, including service entrance conductors, and all wiring above 600V.

1.3 QUALITY ASSURANCE

A. Referenced Industry Standards: The following specifications and standards are incorporated into and become a part of this specification by reference.
   1. Underwriters' Laboratories, Inc. (UL) Publications:
      a. No. 50: Electrical Cabinets and Boxes
      b. No. 467: Electrical Grounding and Bonding Equipment
      c. No. 514: Electrical Outlet Boxes and Fittings
   2. National Fire Protection Association (NFPA):
      a. No. 70: National Electrical Code (NEC)

B. Coordination: Review architectural drawings for areas where outlets occur within specific architectural or structural features and install outlets as shown on architectural drawings; or if not shown, accurately center and align boxes within the architectural features or detail.

C. Acceptable Manufacturers:
   1. Exterior junction or pull boxes:
      a. O-Z Gedney: Type YR
      b. Crouse-Hinds: Type WGB
      c. Oldcastle Synergy
      d. Quazite Type PC

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS REQUIREMENTS

A. Furnish all materials specified herein.

B. All boxes shall be UL listed and labeled.

C. Boxes shall be galvanized steel sheet metal, unless rustproof cast metal is specified or required by the NEC, or unless otherwise specified or indicated on the drawings.

2.2 OUTLET AND DEVICE BOXES

A. Outlet boxes for receptacles in exposed wiring system shall be cast FS boxes with matching device plate. Device plates for exterior installations shall be extra duty in-use type hinged covers. Use FD box for GFI receptacle.

2.3 JUNCTION AND PULL BOXES

A. Dimensions of pull boxes and junction boxes shall not be less than those dimensions required by the National Electrical Code for the number, size and position of conductors entering the box. Extension rings shall not be permitted on a box to increase the volume.

B. Provide box covers for all junction and pull boxes.

2.4 EXTERIOR JUNCTION OR PULL BOXES, FLUSH WITH GRADE

A. Junction or pull box to be mounted flush with grade shall be polymer-concrete raintight and watertight boxes with screw cover lids. Box dimensions shall be as indicated on the drawings. Covers shall be tier 22 polymer-concrete secured to box with stainless steel bolts. Box shall be furnished with continuous neoprene gasket to seal cover. Conduit entry shall be by field drilled openings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All boxes shall be completely accessible and as required by the NEC.

B. Provide an outlet box for each device. Boxes shall not be smaller than indicated in this section of the specifications and shall be larger if required by Article 370 of the National Electrical Code for the number and size of conductors installed.

C. Support every box from structure:
1. Secure to wood with wood screws.
2. Secure to hollow masonry with toggle bolts.
3. Secure to metal with sheet metal screws, machine bolts, or clamps.
4. Anchors for solid masonry and concrete shall be self drilling expansion shields, insert expansion shields, or lead shields with machine bolts. [Power actuated pin studs may be used in concrete.]
5. Hub type cast boxes need not be directly attached to structure if rigid conduit is used and supported in conformance with the NEC.

D. Install pull boxes when any of the following conditions apply:
1. Where indicated on the drawings.
2. Where conduit run exceeds 200 ft. from box to box or box to terminal.
3. Where conduit contains more than 4-90 degree bends or the equivalent offsets.
4. To facilitate conductor installation or to insure that the manufacturer's maximum pulling tension is not exceeded.

E. Do not splice conductors in pull boxes. Splices are not permitted in pull boxes except when approved in writing by the Engineer or where shown on the drawings. Where splices are permitted, make splices with splicing sleeves attached to conductors with hydraulic crimping tool. Split bolt connectors are not acceptable for splices within pull boxes.

F. Where a pull box is required, one shall be installed for each feeder. It shall contain only the feeder conductors. A combined pull box for multiple branch conduits or feeders is not permitted, unless approved by the Engineer or indicated on the drawings. Where permitted for multiple circuits within pull box:
   1. Circuit conductors and feeders shall be individually laced with nylon tie straps of the type with enlarged tab to permit identification of each circuit and feeder within pull box. Identify each with respect to load served.

G. Box covers shall be in place and secured to box.

H. Identification
   1. Refer to ELECTRICAL IDENTIFICATION section of these specifications for additional requirements.

I. Exterior pull or junction boxes
   1. Exterior pull or junction boxes shall be mounted flush with the grade, unless specified elsewhere or indicated to be aboveground on the drawings.
   2. Flush mounted boxes shall be surrounded on all sides and bottom with 6" minimum of concrete. Top of concrete shall be flush with grade.
   3. Seal conduit entries into box with duct seal to prevent entrance of moisture, after conductors are installed.
   4. Taps and splices, where permitted by these specifications within exterior junction boxes, shall be performed with an encapsulating watertight splice or tap kit which insulates and moisture seals the connection. Kit shall consist of the appropriate size and type mold, encapsulating resin and end sealing tape.

3.2 CLEANING AND ADJUSTMENT

A. After completion, clean all work of dirt, paint and construction debris.

END OF SECTION

SECTION 260553

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Extent of electrical identification work is as outlined by this specification.

B. Types of electrical identification work specified in this section include the following:
1. Buried conduit warnings.
2. Electrical power, control and communication conductors.
3. Operational instructions and warnings.
4. Danger signs.
5. Equipment/system identification signs.

C. Refer to Division 01 General Requirements section IDENTIFICATION SYSTEMS, for equipment and system nameplates, and performance data; not work of this section.

1.3 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.

B. UL Compliance: Comply with applicable requirements of UL Std 969, "Marking and Labeling Systems", pertaining to electrical identification systems.

C. ANSI Compliance: Comply with applicable requirements of ANSI Std A13.1, "Scheme for the Identification of Piping Systems".

D. NEMA Compliance: Comply with applicable requirements of NEMA Std No's WC-1 and WC-2 pertaining to identification of power and control conductors.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's data on electrical identification materials and products.

B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.

PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide electrical identification products of one of the following (for each type marker):
1. Almetek
2. Brady, W.H. Company
3. Calpico Inc.
4. Cole-Flex Corporation
5. Direct Safety Company
6. George-Ingraham Corporation
7. Griffolyn Company
8. Ideal Industries, Inc.
9. LEM Products, Inc.
10. Markal Company
11. National Band and Tag Company
12. Panduit Corporation
13. Seton Name Plate Company
14. Tesa Corporation

2.2 ELECTRICAL IDENTIFICATION MATERIALS

A. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.

B. Color-Coded Plastic Tape:
1. Provide manufacturer's standard self-adhesive vinyl tape not less than 3 mils thick by 1-1/2" wide.
a. Colors: Unless otherwise indicated or required by governing regulations, provide orange tape.

C. Underground-Type Plastic Line Marker:
1. Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried cable. Provide detectable type tape.

D. Cable/Conductor Identification Bands:
1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type, either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.

E. Plasticized Tags:
1. Manufacturer's standard pre-printed or partially pre-printed accident-prevention and operational tags, of plasticized card stock with matt finish suitable for writing, approximately 3-1/4" x 5-5/8", with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording, e.g., DANGER, CAUTION, DO NOT OPERATE.

F. Self-Adhesive Plastic Signs:
1. Provide manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., 208V, EXHAUST FAN, RECTIFIER.

2. Colors: Unless otherwise indicated, or required by governing regulations, provide white signs with black lettering.

G. Baked Enamel Danger Signs:
1. General: Provide manufacturer's standard "DANGER" signs of baked enamel finish on 20-gage steel; of standard red, black and white graphics; 14" x 10" size except where 10" x 7" is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording, e.g., HIGH VOLTAGE, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH.

H. Engraved Plastic-Laminate Signs:
1. Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
2. Thickness: 1/8", except as otherwise indicated.
3. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

2.3 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. General Installation Requirements:
1. Install electrical identification products as indicated, in accordance with manufacturer's written instructions, and requirements of NEC and OSHA.
2. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.
3. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

B. Box Identification:
1. After completion, using an indelible wide tip marker, indicate on the cover of each junction and pull box the designation of the circuits contained therein, i.e., A-1, 3, 5. Use a black marker for normal power circuits and a red marker for emergency circuits.

C. Underground Conduit Identification:
1. During back-filling/top-soiling of each exterior underground electrical, signal or communication conduit, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single line marker.
2. Install line marker for every buried conduit.

D. Cable/Conductor Identification:

1. Apply cable/conductor identification, including voltage, phase and feeder number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work. Refer to WIRES AND CABLES section of these specifications for color coding requirements.

E. Operational Identification and Warnings:
1. Wherever required by OSHA or directed by the Owner, to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities equipment by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.

F. Danger Signs:
1. In addition to installation of danger signs required by governing regulations and authorities, install appropriate danger signs at locations indicated and at locations subsequently identified by Installer of electrical work or the Owner as constituting similar dangers for persons in or about project.
   a. High Voltage: Install danger signs wherever it is possible, under any circumstances, for persons to come into contact with electrical power of voltages higher than 110-120 volts.
   b. Critical Switches/Controls: Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons, or damage to or loss of property.

G. Equipment/System Identification:
1. Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication/-control/signal systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated [on drawings or below], provide single line of text, 1/2" high lettering, on 1-1/2" high sign (2" high where 2 lines are required), white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work:
   a. Panelboards, electrical cabinets and enclosures.
   b. Access panel/doors to electrical facilities.
   c. Major electrical switchgear.
   d. Power transfer equipment.
   e. Transformers.
   f. Power generating units.
   g. Automatic transfer switch.
2. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate.
3. Panelboards, individually mounted circuit breakers, and each feeder breaker in the distribution switchboard shall be identified with an engraved plastic laminate sign. Plastic nameplates shall be multicolored laminated plastic with faceplate and core as scheduled. Lettering shall be engraved minimum 1/4" high letters.
   a. 480/277 volt normal power equipment shall be identified with white faceplate with black core.
   b. 480/277 volt emergency power equipment shall be identified with white faceplate with red core.
   c. Equipment identification is to indicate the following:
      1) Equipment ID abbreviation.

2) Voltage, phase, wires and frequency.
3) Emergency or other system.
4) Power source origination. Example:
   a) Panel E3HA
   b) 480/277V, 3 phase, 4 wire
   c) Emergency System
   d) Fed by SWBD-7

d. Submit complete schedule with the shop drawings listing all nameplates and information contained thereon.

END OF SECTION

SECTION 26 05 73.11

SHORT-CIRCUIT/COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

C. Selection of series rated device are not acceptable. Only fully rated devices for calculated fault are acceptable.

1.3 QUALITY ASSURANCE

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
6. IEEE 1584- Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):
1. ANSI C57.12.00- Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 - Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 - Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4. ANSI C 37.41- Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories

C. 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
The National Fire Protection Association (NFPA), NFPA-70; The National Electrical Code (NEC)
1. NEC Article 700.32 - Selective Coordination for Emergency Systems
2. NEC Article 701.27 - Selective Coordination for Legally Required Standby Systems
3. NEC Article 708.54 – Selective Coordination for Critical Operations Power Systems

D. NFPA 70E - Standard for Electrical Safety in the Workplace

E. Submittals for review/approval

1.4 SUBMITTALS FOR CONSTRUCTION

A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. No more than five (5) bound copies of the complete final report shall be submitted. For large system studies, submittals requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short-circuit input and output data. 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. Incident energy and flash protection boundary calculations
7. Comments and recommendations for system improvements, where needed.
8. Executive Summary including source of information and assumptions made.

1.5 QUALIFICATIONS

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

PART2 - PRODUCT

2.1 SHORT CIRCUIT AND PROTECTIVE DEVICE COORDINATION METHODS

A. Provide Protective Device Coordination as a statement of condition only. No NEC code mandated results required. Primary goals are to:
1. Verify the equipment meets the interrupting current rating for the available fault current as determined by the short circuit study.
2. Calculate the incident energy to determine the arc flash boundaries for PPE and safe working clearances.
3. Verify there is selectivity within the electrical distribution system.

B. Selective Device Coordination for use in the following code mandated systems:

1. NEC Article 517.26 - Equipment and systems that reside within health care facilities that provide services to human beings.
2. NEC Article 620.62 - Elevators, Dumbwaiters, Escalators, Moving Walks, Platform Lifts, and Stairway Chairlifts
3. NEC Article 700.27 - Emergency Systems: Illumination or power, or both, when the normal electrical supply or system is interrupted.
4. NEC Article 701.27 - Legally Required Standby Systems. These systems are intended to automatically supply power to selected loads (other than those classed as emergency systems) in the event of failure of the normal source.
5. NEC Article 708.54 - Critical Operations Power Systems. These systems include but are not limited to power systems, HVAC, fire alarm, security, communications, and signaling for designated critical operations areas.

C. 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.

2.2 STUDIES

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer. By using the equipment manufacturer, the study allows coordination of proper breakers, fuses, and current transformers. The coordination study shall begin with the utility company's feeder protective device and include all the electrical protective devices down to and include the largest feeder circuit breaker and motor starter in the 480 Volt motor control centers and power distribution panelboards. The study shall also include variable frequency drives, harmonic filters, power factor correction equipment, transformers and protective devices associated with variable frequency drives, emergency and standby generators associated paralleling equipment and distribution switchgear.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

2.3 DATA COLLECTION

A. Contractor shall furnish all field data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to eliminate unnecessary delays and assure 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 combination may include present and future utility supplies, 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.

2.4 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 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 with available fault at each bus, and interrupting rating of devices noted.
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 faultat 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 bracing 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.

2.5 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-circuits decrement curve and generator damage point.
10. Other system loads 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.

2.6 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E, Annex D.

B. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Alternative methods shall be presented in the proposal.

C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

D. The Arc-Flash Hazard Analysis shall include all MV, 575v, & 480v locations and significant locations in 240 volts and 208-volt systems fed from transformers equal to or greater than 125 kVA.

E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2•

F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full- load conditions.

G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.

H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584 section B.1.2.

2.7 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/Rratio
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.

D. Incident energy and flash protection boundary calculations.

1. Arcing fault magnitude
2. Device clearing time.
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART3 - EXECUTION

3.1 FIELD ADJUSTMENT

A. Electrical contractor to adjust relay and protective device settings according to the recommended settings table provided by the coordination study. OR as an option, field adjustments to be completed by the engineering service division of the equipment manufacturer if a Startup and Acceptance Testing contract exists.

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.

3.2 ARC FLASH WARNING LABELS

A. The vendor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The label shall have an orange header with the wording, "WARNING, ARC FLASH HAZARD", and shall include the following information:
1. Location designation
2. Nominal voltage
3. Flash protection boundary
4. Hazard risk category
5. Incident energy
6. Working distance
7. Engineering report number, revision number and issue date

C. Labels shall be machine printed, with no field markings.

D. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
1. For each 600, 480 and applicable 208-volt panelboards and disconnects, one arc flash label shall be provided.
2. For each motor control center, one arc flash label shall be provided.
3. For each low voltage switchboard, one arc flash label shall be provided.
4. For each switchgear, one flash label shall be provided.
5. For medium voltage switches one arc flash label shall be provided

A. Labels shall be field installed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

3.3 ARC FLASH TRAINING

A. When and if the customer has qualified electrical personnel on staff, the equipment vendor shall provide an optional separate quotation to train personnel of the potential arc flash hazards associated with workingon energized equipment (minimum of 4 hours). Maintenance

procedures in accordance with the requirements of NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces, shall be provided in the equipment manuals.

END OF SECTION

SECTION 262200

TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The work required under this section of the specifications consists of the furnishing, connection and installation of dry type transformers.

B. Definition: Dry type transformers, as described herein, applies to those with primary and secondary voltage connections of 600 volts and less. Autotransformers are not acceptable, except where indicated for buck boost or zig-zag connections.

1.3 QUALITY ASSURANCE

A. Referenced Industry Standards: The following specifications and standards are incorporated into and become a part of this specification by reference.
   1. Underwriter's Laboratories, Inc. (UL) Publications:
      a. No. 506 Transformers (1000 KVA, 3 phase and below; 167 KVA, 1 phase and below)
   2. National Fire Protection Association (NFPA):
      a. No. 70 National Electrical Code (NEC)
   3. National Electrical Manufacturers Association (NEMA):
      a. No. ST-20 Dry-type transformers for general applications
   4. American National Standards Institute (ANSI):
      a. No. C57.12.80 Terminology for Power and Distribution Transformers
      b. No. C57.12.90 Guide for Short Circuit Testing of Distribution and Power Transformers
      c. No. C57.94 Recommended Practice for Installation, Application, Operation and Maintenance of Dry-Type General Purpose Distribution and Power Transformers

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable.
   1. Eaton
   2. GE/ABB
   3. Square D
   4. Hevi-Duty

C. Coordination: Coordinate installation with architectural and structural features, equipment installed under other sections of the specifications and electrical equipment to insure transformer access and clearance minimums are provided, and adequate ventilation is permitted.

1.4 SUBMITTALS

A. Refer to the BASIC ELECTRICAL REQUIREMENTS section for submittal requirements.

B. Manufacturers Product Data:
1. Submit material specifications and installation data for products specified under PART 2 - PRODUCTS. Product data shall indicate sound and temperature rating, overload capacity and efficiency at 25%, 50% and 100% load, available taps, voltage, impedance, nameplate data, wiring diagrams, physical dimensions and net weight. Product data shall also contain certification that transformers are constructed and tested in accordance with standards specified herein.

C. Record Drawings. Include in each set:
1. A complete set of manufacturers product data indicating all post bid revisions and field changes.

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS REQUIREMENTS

A. Furnish all materials specified herein and indicated on the drawings.

B. All transformers shall be UL listed and bear a UL label.

C. Transformers shall be self-cooled, rated for continuous operation at rated KVA, 24 hours per day, 365 days per year with normal life expectancy (IEEE Standard No. 65). KVA ratings shall be as indicated on the drawings.

2.2 GENERAL PURPOSE DRY TYPE TRANSFORMERS

A. Insulation System
1. Single phase 25 - 167 KVA and three phase 30 - 1500 KVA: Transformers shall be rated for average temperature rise by resistance of 115°C. in 40°C. maximum ambient, 30°C average ambient. Transformer insulation system shall be UL rated as 220°C. system.
2. Three phase 3 - 15 KVA: Transformers shall be rated for average temperature rise by resistance of 115°C. Insulation system shall be 180°C.
3. Single phase up through 250 VA: Transformers shall be rated for 55°C. rise by resistance. Insulation system shall be 105°C.

B. Sound rating shall not exceed NEMA and ANSI standards for KVA rating. Internal vibration dampening shall be provided as a standard feature of all transformers.

C. Single phase transformers rated up to 15 KVA shall have two, 5 percent full capacity taps below normal rated primary voltage. All other single phase and all three phase transformers shall be provided with six 2-1/2% full capacity taps, two above and four below normal voltage unless only four 2-1/2% taps, two above and two below normal voltage, are standard.

D. Construction and Enclosures
1. Transformers 30 - 1500 KVA: Transformer enclosures shall be open, ventilated, drip-proof with removable front and rear cover panels. Transformers shall be suitable for floor mounting, unless wall mounting is indicated on the drawings.
2. Transformers up through 25 KVA: Transformers shall be totally enclosed, non-ventilated with a resin encapsulated core and coil and drip-proof housing. Removable panel section shall permit access to wiring compartment.

E. Transformer primary and secondary voltage shall be as indicated on the drawings.

F. Nominal transformer impedance shall be 4.5 percent minimum, unless otherwise indicated on the drawings.

G. Core assemblies and the center ground connection point of the coil secondaries shall be grounded to their enclosures by adequate, flexible ground straps. Provide grounding lug at the strap to enclosure bonding location for connection of three conductors; the primary and secondary equipment grounding conductors and the grounding electrode conductor.

H. Provide weather shield and stainless steel enclosures on transformers indicated on drawings and for all exterior installations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Dry transformers larger than 15 KVA shall be floor mounted, unless wall or suspension mounting is indicated on the drawings. Transformers 15 KVA and smaller shall be wall mounted. Installation shall provide not less than twelve inch clearance from walls or equipment. Floor mounted transformers shall be mounted on neoprene, waffle type vibration pads 5/8" thick. Where transformers are indicated on the drawings, or specified herein to be mounted on suspended channels of angles or wall mounted, transformers shall be bolted to structure with 5/8" thick vibration pad between transformer base and structural surface. Loosen shipping bolts to free up internal vibration mounts on core and coil assembly.

B. Primary and secondary connections to dry type transformers shall be made with flexible conduit.

C. The secondary windings of each dry type transformer shall be grounded in accordance with the National Electrical Code requirements for separately derived electrical systems. Extend a grounding electrode conductor from the transformer grounding lug to the nearest building structural steel or main column rebar. Connect the primary and secondary feeder equipment grounding conductors to the grounding lug. Refer to the secondary grounding section of these specifications for additional requirements.

D. Install secondary overcurrent protective device within 10 feet of conductor length. Where none is indicated on plans, provide enclosed circuit breaker within 10 feet rated at 125 percent of the transformer full load ampacity but not greater than the secondary conductor ampacity.

E. Do not install equipment over transformer, unless indicated on the drawings.

F. Locate transformers to provide working clearance and full accessibility as required by the National Electrical Code.

G. For the installation of buck-boost transformers, where three phase load is to be served, three single phase transformers are required. Provide 4" x 4" x 24" wiring trough with hinged cover for both primary and secondary interconnections. Connection to wiring trough from transformer shall be with flexible conduit.

3.2 CLEANING AND ADJUSTMENT

A. Prior to final inspection, under maximum available load, measure secondary voltage and adjust tap setting to deliver nominal rated voltage within the percentage limits of one tap setting. Record the voltages of each transformer and submit in accordance with the requirements specified in the basic electrical requirements section.

B. After completion, clean the interior and exterior of dirt, paint and construction debris.

C. Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

3.3 IDENTIFICATION

A. Refer to the ELECTRICAL IDENTIFICATION section of these specifications for identification requirements.

3.4 FIELD QUALITY CONTROL

A. Refer to the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.

END OF SECTION

SECTION 262413.01

SWITCHBOARDS – FRONT ACCESSIBLE
GROUP MOUNTED FEEDER DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The work required under this section of the Specifications consists of the installation of all switchboards designated on the drawings to have group mounted feeder devices with front access only construction for use on systems 600 volts and below. All materials and devices which are an integral part of the switchboard shall be provided under this section of the specifications.

B. Definition: Switchboards are floor mounted assemblies of one or more enclosed vertical section containing circuit breakers, switches, meters, fuses, and terminals essential to operation of electrical equipment. A dead front switchboard has no exposed live parts on front.

1.3 QUALITY ASSURANCE

A. The following specifications and standards are incorporated into and become a part of this Specification by reference.
   1. National Electrical Manufacturers Association (NEMA) Standards:
      a. PB-2: Dead Front Distribution Switchboards
      b. PB-2.1: General Instruction for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards rated 600 volts or less.
      c. SG-3: Low Voltage Power Circuit Breakers.
   2. Underwriters Laboratories, Inc. (UL):
      a. UL-489: Molded Case Circuit Breakers and Circuit Breaker Enclosures
      b. UL-891: Deadfront Electrical Switchboards
   3. Institute of Electrical and Electronics Engineers (IEEE):
      a. STD-241: IEEE Recommended Practices for Electric Power Systems in Commercial Buildings
   4. National Fire Protection Association (NFPA):
      a. NFPA-70: The National Electrical Code
   5. American National Standards Institute (ANSI):
      a. C37.13: Low-Voltage AC Power Circuit Breakers used in Enclosures
      b. C37.16: Related Requirements and Application Recommendations for Low-Voltage Power Circuit Breakers and AC Power Protectors, Preferred Ratings

B. Equipment Dimensions
   1. Dimensions indicated on the drawings are maximum allowable and shall not be exceeded. Where switchboards of acceptable manufacturers listed exceed the maximum dimensions, products of such manufacturers shall not be acceptable.

C. Coordination
   1. Review shop drawings submitted under this and other sections, as well as other divisions, to ensure coordination between work required among different trades. Coordinate the installation sequence with other contractors to avoid conflicts and to provide the fastest overall installation schedule. Coordinate installation with architectural and structural features, equipment installed

under other sections of the specifications and electrical equipment to insure access and so that clearance minimums are provided.

1.4 SUBMITTALS

A. Refer to the BASIC ELECTRICAL REQUIREMENTS section for submittal requirements.

B. Product Data: Switchboards including, but not limited to, voltages, number of phases, frequencies, and short-circuit and continuous current ratings. Provide application data for main and branch circuit-breakers, sections, main buses, and basic insulation levels.

C. Shop Drawings: Layout drawings of switchboards showing accurately scaled basic equipment sections including auxiliary compartments, section components, and combination sections.

D. Wiring Diagrams: For switchboards showing connections to electrical power feeders and distribution branches. Differentiate between portions of wiring that are manufacturer-installed and portions that are field-installed.

E. Closeout Submittals: As follows:
1. Record Drawings: Include in each set:
a. Complete set of switchboard manufacturers' product data and shop drawings indicating all post bid revisions and field changes.
b. Schedule of each overcurrent protection device indicating unit ampere rating and trip rating.
c. Copy of the ground-fault system performance test as required by Article 230-95(c) of the NEC.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Deliver switchboards and components properly packaged and mounted on pallets, or skids to facilitate handling of heavy items. Utilize factory-fabricated type containers or wrappings for switchboards and components which protect equipment from damage. Install gravity measuring meters in containers which indicate whether container has been bumped or dropped. Return G-meters to manufacturer for re-use upon delivery of switchboards. Inspect equipment to ensure that no damage has occurred during shipment.

B. Store switchboard equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle switchboard equipment carefully to prevent physical damage to equipment and components. Remove packaging, including the opening of crates and containers, avoiding the use of excessive hammering and jarring which would damage the electrical equipment contained therein. Do not install damaged equipment; remove from site and replace damaged equipment with new.

1.6 SEQUENCING AND SCHEDULING

A. Schedule delivery of switchboard equipment which permits ready building ingress for large equipment components to their designated installation spaces. Coordinate delivery of equipment with the installation of other building components.

B. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate with other electrical work including raceways, electrical boxes and fittings, and cabling/wiring work, as necessary to interface installation of switchboards with other work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton
2. GE/ABB
3. Square D

2.2 GENERAL

A. AC Dead-Front Distribution Switchboards: Provide factory-assembled, dead-front, metal-enclosed, self-supporting secondary power switchboards, of types, sizes, electrical ratings and characteristics indicated; consisting of vertical panel units, and containing circuit-breakers of quantities, ratings and types indicated. Provide copper main bus and connections to circuit-breaker branches of sufficient capacity to limit rated continuous current operating temperature rise of no greater than 65°C above average ambient temperature of 25°C; with main bus and tap connections silver-surfaced and bolted tightly according to manufacturer's torquing requirements for maximum conductivity. Brace bus for short-circuit stresses up to maximum interrupting capacity. Provide accessibility of line and load terminations from front of switchboard. Equip units with built-in lifting eyes and yokes; and provide vertical individual panel units, suitable for bolting together at project site. Construct switchboard units for the following environment:
1. Installation: Outdoors, NEMA Type 3R.

B. Provide accessory and instrumentation small wiring, necessary fuse blocks and terminal blocks within the switchboard. Control components, such as control transformers, fuse blocks, relays, etc., shall be suitably marked for identification where mounted on the switchboard corresponding to appropriate designations on manufacturer's wiring diagrams. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

2.3 BUSSING

A. All bus bars shall be silver-plated copper with bolted connections at joints. The bus bars shall be of sufficient size to limit the temperature rise to 65°C rise based on UL tests, and rated to withstand mechanical forces exerted during short circuit conditions when directly connected to a power source having an available fault current as shown on the drawings. Provide full capacity neutral where a neutral is indicated on the drawings.

B. A ground bus rated a minimum of 25% of main bus ampacity shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard. An incoming ground lug shall be furnished. Other ground lugs for feeder circuits shall also be supplied as shown in the schedules on the drawings.

C. All hardware used on conductors shall be high-tensile strength and plated. All terminals shall be of the anti-turn solderless type suitable for Cu or Al cable of sizes indicated for 75°C cable.

2.4 CONSTRUCTION

A. Switchboards shall be front accessible. All sections of the switchboard shall be 30" deep except service sections containing large ampacity main disconnects which may be deeper as required. All sections of the switchboard shall align so that the back of the complete structure is in-line.

B. Construction shall allow maintenance of incoming line terminations, main device connections and all main bus bolted connections to be performed without rear access. The feeder or branch devices shall be removable from the front and shall be panel mounted with the necessary device line and load connections front accessible. Provide lugs on all devices for cable sizes shown on drawings.

2.5 METERING

A. Where indicated on the drawings, provide a separate customer metering compartment with front hinged door and include the following:
1. Current transformers
2. Potential transformers including primary and secondary fuses with disconnecting means for metering as shown on the drawings.
3. Indicating ammeter with ammeter switch indicating voltmeter with voltmeter switch and KWHR demand meter.

2.6 ENERGY REDUCTION MAINTENCE SWITCH

A. Provide main breaker with indicator light and all necessary components.

B. Coordinate settings with arc flash study results.

2.7 OVERCURRENT DEVICES - GENERAL

A. Main protective devices shall be fixed mounted molded case breaker with interrupting rating, frame and trip ratings as shown on the drawings.

B. Group mounted feeder protective devices shall be molded case breaker type with frame and trip rating as shown on the drawings and have additional characteristics as specified.

C. Devices shall be manually operated (MO) unless electrically operated (EO) is indicated on the drawings.

2.8 MOLDED CASE BREAKERS

A. Protective devices as shown shall be molded case circuit breakers providing complete circuit overcurrent protection by having inverse time and instantaneous tripping characteristics, and where applicable, be current limiting.
1. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip free. Automatic tripping of the breaker shall be clearly indicated by handle position. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by means of arc chutes.
2. Circuit breaker interrupting capacities shall be as indicated on the drawings or as specified hereinafter. Where applicable, circuit breakers shall be listed for series application.

B. Breakers 150 ampere and below shall be thermal-magnetic trip with inverse time current characteristics. Breakers with 250 and 400 ampere frame shall be thermal-magnetic or solid-state trip, as applicable.

C. Breakers with 600 amperes frame and above shall be solid-state trip complete with built-in current transformers, solid-state trip unit and flux transfer shunt trip. Breakers shall have trip rating plugs with ratings as indicated on the drawings. Rating plugs shall be interlocked so they are NOT interchangeable between frames and interlocked such that a breaker cannot be latched with the rating plug removed.
1. Trip units shall have adjustable short time setting with a fixed instantaneous override for circuit protection. Main breakers shall be provided with additional short delay trip time adjustment for increased system coordination.
2. Breakers shall have built-in test points for testing long delay, instantaneous and ground fault functions of the breaker by means of a 120 volt operated test kit. Provide one test kit capable of testing all breakers 600 ampere and above.
3. Where indicated on the drawings, provide built-in ground fault protection with adjustable pick-up rating not exceeding 1200 amperes; ground fault time delay shall be adjustable 0.1 to 0.5 seconds. Provide neutral ground fault current transformer for four wire systems.

D. Where indicated on the drawings, provide zero sequence ground fault protection system with necessary sensor, monitor, test panel, shunt trip and control power source for use with breakers indicated.

2.9 NAMEPLATES

A. Engraved nameplates shall be furnished for all main and feeder circuits including control fuses and also for all indicating lights and instruments. Nameplates shall give item designation and circuit number as well as frame size and appropriate trip rating. Furnish Master nameplate giving switchboard designation, voltage ampere rating, short circuit rating, manufacturer's name, general order number and item number. Refer to ELECTRICAL IDENTIFICATION section of this specification.

2.10 FINISH

A. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchboard shall be ANSI 61 and use the manufacturer's standard process.

2.11 CONTROL POWER TRANSFORMERS

A. Control power transformers with primary and secondary protection shall be provided as indicated on the drawings or where required to operate ground fault systems, adequately sized for required burdens.

2.12 OUTDOOR ENCLOSURE

A. Switchboard shall be enclosed in an outdoor rain-proof enclosure conforming to the requirements of UL 891. They shall have roofs sloping toward the rear. Outer sections shall be the same widths as indoor structures. Each end of the outdoor structure shall have a 1-1/4" end trim.

B. All external panels and doors shall be bolted using corrosion resistant hardware and neoprene seals where exposed to weather. The enclosure shall be provided with front hinged doors for each section. Front door shall be supplied with provisions for padlocking. A steel floor shall be provided in walk-in aisle space. Ventilating openings to be provided in the front doors, one in bottom area and one in upper area, complete with replaceable fiberglass air filters.

C. An Underwriters Laboratory rainproof label shall be provided for the enclosure.

D. The enclosure shall be provided with undercoating applied to entire under surface to retard corrosion.

E. The construction of the enclosure shall be modular so future sections can be added with affecting rainproof integrity.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine areas and conditions under which switchboards and components are to be installed, and notify General Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.2 INSTALLATION OF SWITCHBOARDS:

A. Install switchboards as indicated, in accordance with manufacturer's written instructions, and with recognized industry practices; complying with applicable requirements of NEC, NEMA's Stds Pub/No. PB 2.1, and NECA's "Standard of Installation".

B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486 A and B, and the National Electrical Code.

3.3 FIELD QUALITY CONTROL

A. Refer to ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.

B. Contractor shall verify in the field that all factory-made connections and terminations are torqued to manufacturer's recommended tolerances.

C. Verify operation of the energy reduction maintenance switch.

3.4 ADJUSTING AND CLEANING

A. Adjust operating mechanisms for free mechanical movement.

B. Touch-up scratched or marred surfaces to match original finishes.

3.5 GROUNDING

A. Provide equipment grounding connections for switchboards as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

3.6 FIELD QUALITY CONTROL

A. Subsequent to wire and cable hook-ups, energize switchboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION

SECTION 262416

PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The work required under this section of the specifications consists of the furnishing, installation and connection of lighting and appliance panelboards and distribution type panelboards.

B. Panelboards designated as HDA, HDB, DA, DB, etc., or indicated on the drawings shall be distribution type panelboards. Those designated as HA, HB, A, B, etc., are lighting and appliance type panelboards.

C. Definitions: The term panelboard, as used in this specification or on the drawings, shall mean the complete assembly including the enclosure, bus work, trim hardware and circuit breaker or fused devices. The words panel and panelboard are used synonymously in these contract documents.

1.3 QUALITY ASSURANCE

A. Industry Referenced Standards. The following specifications and standards are incorporated into and become a part of this Specification by Reference.
   1. Underwriters' Laboratories, Inc. (UL) Publications:
      a. No. 50: Cabinets and Boxes, Electrical
      b. No. 67: Panelboards
      c. No. 489: Molded Case Circuit Breakers and Circuit Breaker Enclosure
   2. Federal Specifications (Fed Spec):
      a. WC-375: Circuit Breakers
   3. National Electrical Manufacturer's Association (NEMA) Publications:
      a. No. PB-1: Panelboards
      b. No. AB-3: Molded Case Circuit Breakers
   4. National Fire Protection Association (NFPA):
      a. No. 70: National Electrical Code (NEC)

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable.
   1. GE/ABB
   2. Eaton
   3. Square D

C. Coordination: Coordinate installation with architectural and structural features, equipment installed under other sections of the specifications and electrical equipment to insure panel access and insure that clearance minimums are provided.

1.4 SUBMITTALS

A. Refer to BASIC ELECTRICAL REQUIREMENTS for submittal requirements.

B. Manufacturers Product Data:
1. Submit material specifications and installation data for products specified under Part 2 - Products to include:
a. Circuit breakers
b. Panelboards

C. Shop Drawings: Submit shop drawings to indicate information not fully described by the product data to indicate compliance with the contract drawings.
1. Include electrical characteristics and ratings for each panelboard with dimensions, mounting, bus material, voltage, ampere rating, mains, poles and wire connection, and any accessories. Indicate method of ground bus attachment to enclosure.
2. Include front elevation bussing diagram indicating each bussing circuit breaker position.
3. Provide a schedule indicating circuit breaker type, trip and size, poles, frame type, and interrupting capacity.

D. Record Drawings. Include in each set:
1. A complete set of panelboard manufacturers product data and shop drawings indicating all post bid revisions and field changes.
2. A copy of each panelboard directory incorporating all post bid revisions and field changes.

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS REQUIREMENTS

A. Furnish all materials specified herein.

B. Panels shall be of the dead front safety type.

C. Provide panels complete with factory assembled circuit breakers connected to the bus bars in the positions shown on the panel schedules or bus diagrams as indicated on the drawings.

D. Number all panelboard circuits in the following sequence:
1. Circuits No. 1 and 2, Phase A; Circuits No. 3 and 4, Phase B; Circuits No. 5 and 6, Phase C. Connect two pole breakers to phase indicated on the drawings.

2.2 BUSSING AND INTERIORS

A. All bus bars shall be copper. Main lugs and main breakers shall be UL approved for copper or aluminum conductors and shall be of a size range for the conductors indicated on the drawings. Each panel shall contain an equipment grounding bus. Each lighting and appliance panelboard shall contain a full size insulated neutral bus. Where a distribution type panelboard is indicated on the drawings to have a neutral bus, the bus shall be insulated and full size, unless otherwise indicated on the drawings.

B. The neutral and ground busses shall have a sufficient number of lugs to singularly terminate each individual conductor requiring a connection.

C. The ground bus shall be factory brazed, riveted or installed on studs welded to the panel enclosure or panel frame. The ground bus shall not be attached to the panel interior.

D. Where designated on panel schedule as "space", include all necessary bussing, device support and connections. Provide blank cover for each space.

2.3 ENCLOSURES

A. Panelboard width shall not be less than 20", nor more than 22" unless specific width is indicated on the drawings. Panelboard depth shall not exceed 5-3/4".

B. Distribution panelboard width shall not be less than 31" and the depth shall not exceed 14".

C. Review panelboard schedules and system one line diagram and provide panelboard gutters and bending space at terminals to conform to the National Electrical Code.

D. Provide concealed captive clamping devices, concealed hinges and lock for all flush mounted panels. Key all panels throughout project alike.

E. Provide a directory card, metal holder, and transparent cover permanently mounted on inside of doors.

F. Where indicated on the drawings or required for the environmental conditions, provide a NEMA 3R enclosure. Mount a thermostatically controlled 120V electric space heater in the enclosure.

2.4 CIRCUIT BREAKERS

A. Interrupting rating of all circuit breakers in panelboards operating on 208Y/120 volt system shall have UL rating of not less than 10,000 RMS symmetrical amps at system voltage. Provide circuit breakers with higher interrupting capacity when indicated on the drawings.

B. Circuit breakers shall be provided with trip rating, poles and minimum interrupting rating as indicated on the drawings or specified herein.

C. Multi-pole breakers shall be common trip and common reset; tie handle connection between single pole breakers is not acceptable.

D. Branch circuit breakers in lighting and appliance panels shall be quick-make, quick-break, thermal magnetic type bolted to the bus. Circuit breakers in distribution type panelboards shall be bolted to the bus except, Square D I-line style plug in devices are acceptable.

E. Molded case circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for 100 ampere frame or less. Magnetic trip shall be adjustable for breakers with 600 ampere frames and higher. Factory setting shall be HI, unless otherwise noted.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount panelboards with top circuit not more than 6'-6" above finished floor.

B. Lace and group conductors installed in panels with nylon tie straps. Only one conductor shall be installed under terminal of individual circuit breakers. Form and train conductors in panel enclosure neatly parallel and at right angles to sides of box. Uninsulated conductor shall not extend beyond one-eights inch from terminal lug.

C. Do not splice conductors in panels. Where required, install junction box adjacent to panel and splice or tap conductors in box. Refer to number of conductors in a conduit limitation defined in the conductors and cables section of the specifications and do not exceed.

D. Mounting and Support
   1. Mounting
      a. Enclosure shall be secured to structure by a minimum of four (4) fastening devices. A 1.5" minimum diameter round washer shall be used between head of screw or bolt and enclosure.
      b. Enclosures shall be mounted where indicated on the drawings or specified herein. Support from the structure with fastening device specified.
      c. Attach enclosure directly to masonry, concrete, or wood surfaces.
      d. Mount enclosure on metal channel (strut), which is connected to structure with fastening device specified, for installations on steel structure or sheet rock walls.

E. Conductors not terminating in panelboard shall not extend through or enter panel enclosure.

F. Maintain conductor phase color code requirement described in the wires and cables section of the specifications.

G. Provide in each panelboard with a typewritten circuit directory laminated mounted under clear plastic in a metal directory frame on interior of panel door. Directory shall reflect any field changes or additions.

H. The trim covers of all flushed mounted panelboards shall be field painted. Refer to the painting section of the specifications. Locks and exposed trim clamps shall not be painted.

I. Install push-in knock-out closure plugs in any unused knock-out openings.

J. Identification
   1. Panelboards and individually mounted circuit breakers shall be identified.
   2. Refer to the ELECTRICAL IDENTIFICATION section of these specifications for identification requirements.
   3. Submit complete schedule with the shop drawings listing all nameplates and information contained thereon.

3.2 CLEANING AND ADJUSTMENT

A. After completion, clean the interior and exterior of dirt, paint and construction debris.

B. Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

C. Adjust and align panelboard interior and trim in accordance with manufacturers recommendations, and to eliminate gaps between the two.

3.3 FIELD QUALITY CONTROL

A. Refer to the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.

B. Contractor shall verify in the field that all factory-made connections and terminations are torqued to manufacturer's recommended tolerances.

END OF SECTION

SECTION 262726

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The work included under this section of the specifications consists of the installation of wiring devices, i.e. switches and receptacles and device plates. All materials shall be provided under this section of the specifications.

B. Select devices from lists of acceptable devices contained in this section of the specifications.

C. The catalog numbers listed herein for switches and receptacles are for items with brown finish. Notwithstanding catalog numbers, the switches and receptacles provided on this project shall have [ ] finish unless otherwise indicated. All special purpose receptacles shall be provided in black finish.

1.3 QUALITY ASSURANCE

A. NEMA WD-1 General Purpose Wiring

B. NEMA WD-5 Specific Purpose Wiring Devices

PART 2 - PRODUCTS

2.1 RECEPTACLES

A. Select receptacles from those listed herein. Designation in parenthesis is NEMA configuration required.
   1. Ground Fault Interrupter (GFI) 15 amp, 125 volt duplex receptacle: Hubbell GFWRST20.

2.2 DEVICE PLATES

A. Device plates shall be one piece single or multi-gang type selected to match the device or combination of devices.
   1. All devices installed in areas exposed to the weather and where indicated on the drawings shall be provided with a weatherproof extra duty, in-use device cover.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. The mounting height of devices are indicated in the legend on the drawings and is intended to mean the bottom of the device above the finished floor unless otherwise indicated on the drawings.

B. Review Engineering Drawings for any device requiring specific location.

C. Mount all devices within outlet boxes.

END OF SECTION

SECTION 263213

ENGINE DRIVEN EMERGENCY POWER SUPPLY SYSTEM EQUIPMENT ONLY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The work required under this section of the specifications consists of the supply of the complete Engine Driven Emergency Power Supply System. All materials and devices which are an integral part of this system shall be provided under this section of the specifications. Concrete foundations, wire, cable, conduit and installation are not included.

B. Definition: The Emergency Power Supply System (EPSS) shall consist of one or more engine driven generator sets, each of which contains an engine directly coupled to an electric generator, together with the necessary switchgear, controls, accessories, transfer devices, and fuel supply to provide electric power for the duration of any failure of the normal power supply.
   1. Automatic Transfer Switch (ATS): An automatic transfer switch is self-acting equipment for transferring one or more load conductor connections from one power source to another.

1.3 QUALITY ASSURANCE

A. The following specifications and standards are incorporated into and become a part of this specification by reference.
   1. National Fire Protection Association (NFPA):
      a. NFPA-37 Combustion Engines
      b. NFPA-70 National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701 and 702,
      c. NFPA-99 Essential Electrical Systems for Health Care Facilities
      d. NFPA-110 Emergency and Stand-By Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement.
   2. Institute of Electrical and Electronics Engineers (IEEE) Standards:
      a. IEEE 446 IEEE Recommended Practices for Emergency and Standby Power Systems for commercial and industrial applications.
      b. IEEE 472 Voltage Surge Withstand Capabilities
   3. National Electric Manufacturers Association (NEMA) Standards:
      a. NEMA MG1-1998 part 32. Alternator shall comply with the requirements of this standard.
      b. ICS1-109 Test and Test Procedures for Automatic Transfer Switches
      c. ICS 10-2005 Part 1 A.C. Automatic Transfer Switch
   4. Underwriters Laboratories Inc. (UL) Publications:
      a. UL 1008 Automatic and Non-Automatic Transfer Switches
      b. UL508. The entire control system of the generator set shall be UL 508 listed and labeled.
      c. UL142 – Sub-base Tanks
      d. UL 1236 – Battery Chargers
      e. UL2200 – The generator set shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed.
   5. American National Standards Institute (ANSI):
      a. C37.90a Voltage Surge Withstand Capability
   6. The control system for the generator set shall comply with the following requirements.

a. CSA C22.2, No. 14 – M91 Industrial Control Equipment.
b. EN50082-2, Electromagnetic Compatibility – Generic Immunity Requirements Part 2: Industrial
c. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
d. FCC Part 15, Subpart B.
e. IEC8528 part 4. Control Systems for Generator Sets
f. IEC Std 801.2, 801.3 and 801.5 for susceptibility, conducted and radiated electromagnetic emissions.

7. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation and service, in accordance with ISO 9001.

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable:
1. Engine Driven Generator Sets:
a. Caterpillar
b. Cummins/Power Generation
c. MTU
2. Transfer Switches:
a. Caterpillar/ABB TrueONE Series with ZTG-T Controller
b. ASCO
c. Russelectric
d. Cummins/Power Generation OTEC Series with 40- 01 Controller
3. Sub-Base Fuel Tanks by engine manufacturer or approved 3rd party supplier.

C. Equipment Dimensions:
1. Dimensions indicated on the drawings are maximum allowable and shall not be exceeded. Where equipment of acceptable manufacturers listed exceeds the maximum dimensions, products of such manufacturers shall not be acceptable.

1.4 SUBMITTALS

A. Refer to the SHOP DRAWINGS, PRODUCT DATA AND SAMPLES Section for required procedures.

B. Manufacturer's Product Data:
1. Submit material specifications and installations data for products specified under Part 2 - Products to include:
a. Engine driven generator sets
b. Transfer switches
c. Sub-base fuel tanks

C. Shop Drawings: Submit shop drawings to indicate information not fully described by the product data to indicate compliance with the contract drawings. Submittals containing less than the information listed below will be rejected.
1. Shop drawings for the engine driven generator sets shall contain not less than the information listed as follows:
a. Certification that the engine driven generator set(s) furnished will serve electrical loads indicated including motor starting loads as listed in this specification (note provide complete motor data such as starter type listed in specifications with max voltage and freq. performance required) with type(s) of starting indicated.
b. Stand-by rating of engine driven generator set(s) including voltage and phase.
c. Frequency and voltage regulation with maximum voltage dip and time of recovery to stable operation.
d. Output voltage adjustment range in percentage of rated plant voltage.
e. Alternator type and method of connection to prime mover.
f. Components contained in alternator instrument panel.

g. Rating of engine at operating speed, engine cycle and number of cylinders.
h. Type of engine lubrication system and verification of components specified.
i. Type of engine governor.
j. Components contained in engine instrument panel.
k. Fuel consumption at ¼, ½, ¾ and full load.
l. Starting batteries including ampere hour rating.
m. Verification that all accessories specified is to be provided. This includes day tank with capacity indicated, cold weather starting aid with rating and voltage indicated, exhaust system with muffler type indicated, and outdoor housing (where applicable) with verification of space available within housing for batteries.
n. Alternator data sheet with complete data including reactance values.
o. Terminal board connection diagram where reconnectable generators are specified.
p. Circuit breaker type, rating, A.I.C. rating and cable capacity of lugs.

2. Shop drawings for the transfer switch shall contain not less than the information listed as follows:
a. List of accessories contained in the control panel.
b. Withstand rating in RMS symmetrical amperes.

D. Quality and Service:
1. All materials and parts of the EPSS shall be new and unused. Each component shall be of current manufacture from a firm regularly engaged in the production of such equipment. Units and components offered under these specifications shall be covered by the manufacturer's parts and labor warranty for a minimum of five (5) years from date of Owner acceptance of the project on a new machine, a copy of which shall be included in the shop drawings submittal.
2. Submittals will be accepted only on engine driven generator sets and transfer switches which can be properly maintained and serviced without requiring the Owner to stock spare parts or wait longer than twenty-four hours for service. Submittals shall include the nearest location of permanent parts outlet from which parts may be obtained and written assurance that trained service personnel will be available on twenty-four hour's notice. Units with service centers more than 250 miles from project site will not be accepted.

E. Record Drawings
1. Include in each set three sets of operating, maintenance, and parts manuals covering all components for the EPSS. Each supplier shall provide instructions to the Owner in operation and maintenance of his equipment, both in written form and with on-site personnel for a minimum of four hours.
2. A schedule of each motor, indicating actual horsepower and means of starting, connected to the EPSS shall be provided to the Owner with the record drawings.

PART 2 - PRODUCTS

2.1 ENGINE DRIVEN EMERGENCY POWER SUPPLY (EPS)

A. Engine
1. Each engine driven emergency power supply (EPS) shall be an internal combustion diesel driven prime mover. The generator sets shall have the ratings as indicated on the drawings.
2. The rated net horsepower of the engine at the generator synchronous speed, with all accessories, shall not be less than that required to product the KW specified in paragraph 1 above. The horsepower rating shall take into account generator efficiency and all accessory losses such as fans, battery charger, etc. The generator set shall be capable of producing the specified KW (without overload) for the duration of the power outage, under the following ambient conditions:
a. Altitude: 500 feet above mean sea level.
b. Air temperature at engine intake: 104 degrees F.
c. Humidity Range: 10 - 95%.
3. Included with the shop drawing submittal shall be the manufacturer's estimate of supply fuel and oil consumption for the engine. The engine shall have an oil filter with replaceable elements, a lube oil cooler, and an oil reservoir.

4. The engine shall be equipped with a suitable governor (engine speed control) to maintain frequency within limit specified below by controlling engine and generator speed. Manufacturer shall indicate in submittal data whether mechanical, hydraulic, electrical, or hybrid governors are provided.
   a. Type: Isochronous 0.25% maximum
   b. Stability: 0.25% maximum steady state frequency variation at any constant load from no load to full load.
   c. Regulation: 5% maximum frequency deviation between no-load steady state and full load steady state.
5. The engine shall be electric start, provided with a solenoid energized motor with either positive engagement or clutch drive to the engine. The engine starting batteries shall be lead-acid recombination type, with individual cell construction. Block batteries will not be accepted. The voltage shall be as called for by the engine manufacturers with quantity of cells as follows:
   a. 12 volt ..... 10 cells
6. Cranking capacity shall be calculated to 0.85 VPC final voltage and shall be capable of turning the engine at its rolling current for a minimum of 3 minutes (180 seconds). Operating temperature shall be 50°F. minimum and 90°F. maximum indoors and 32°F. minimum for outdoor housed units. Exterior installations shall contain heaters as required to maintain the minimum specified temperature powered from the building emergency system. Capacity in the batteries shall be provided for any solenoids or other accessories required by NFPA 110 to be operated from the EPS batteries. In addition to the above, minimum amp hour capacity at the eight hour rate shall be as follows:
   a. 101 - 200 KW = 70 AH
   b. 201 - 350 KW = 90 AH
   c. 1001 - 1250 KW = 150 AH
7. The engine starting batteries shall be sealed lead-acid recombination type. Batteries shall be rack mounted adjacent to the engine set or inside the weatherproof plant housing as noted on the plans to minimize the distance from the batteries to the starter. Amperage shall have a rating of no less than 20 amps.
   a. Provide battery straps and battery heater per NFPA 110.
8. A float type battery charger, compatible with the batteries selected, shall be furnished at the engine which shall maintain the starting batteries at full charge.
9. It shall have an equalize rate and a float rate charging system. An ammeter and voltmeter shall indicate the charge rate and the circuit shall be protected by either fuses or circuit breakers. The charger or charging circuit shall be so designed that it will not be damaged during the engine cranking cycle, for example, by a current limiting charger or a crank disconnect relay. It shall also be capable of recharging a discharged battery in 12 hours while carrying normal loads. The charger shall be equipped with alarm relays as required for remote annunciation equipment.
10. The engine shall be liquid cooled. The type of liquid cooling system shall be unit mounted radiator - consideration shall be given for air temperature rise across the engine in addition to ambient. Minimum capacity shall be rated for 104°F. minimum engine ambient temperature plus air temperature rise across the engine.
    a. Provide an electric heater, thermostatically controlled, in the engine coolant system as a cold weather starting aid. Heater shall be for operation on 120 volt single phase A.C. for 2500 watt units and below and on 208 volt single phase A.C. for all other units and shall be permanently connected to a circuit from the building electrical system. Heater shall maintain 70°F. to 90°F.
    b. Provide isolation valves or quick connect couplings for jacket water heater.
11. Air Supply/Exhaust System
    a. Cleaner: An air cleaner and silencer shall be furnished, located and mounted as recommended by the engine manufacturer.
    b. Exhaust: An exhaust system of suitable size, configuration, and material in accordance with engine manufacturer's recommendations shall connect the exhaust outlet of the engine to a silencer. The type of silencer shall meet the requirements of engine manufacturers. The silencer shall be located inside outdoor enclosure or in the engine room as noted on the plans.

c. The exhaust system including silencer shall be of such size that back pressure on the system will not exceed the back pressure permitted by the engine manufacturer's recommendation. A flexible connection shall be mounted at the engine exhaust outlet and the discharge end shall be protected against entry of precipitation. Piping and silencer within reach of personnel or with 8'-0" of finished floor or grade shall be protected by screening and shall be insulated with two inches of calcium silicate insulation with aluminum jacket. All exhaust piping shall be gas tight.

12. The engine instrument panel shall be mounted at the engine and shall contain the following:
    a. Oil pressure gauge to indicate lubricating oil pressure.
    b. Temperature gauge to indicate cooling medium temperature.
    c. Hour meter to indicate total actual running time.
    d. Battery charging meter to indicate satisfactory performance of battery charging means.
    e. Other instruments as recommended by the manufacturer for proper maintenance.
    f. Manual stop/start controls: All instruments, controls, and indicating lights shall be properly identified. All wires shall be individually identified and must agree with the wiring diagram provided. All wiring shall be harnessed or flexibly enclosed. Terminals on all terminal blocks shall be individually identified.

B. Generator
1. The generator shall be an engine-driven single or two bearings type, synchronous, brushless, and conforming to applicable standards. It shall be connected to the engine flywheel by means of a flexible type coupling for single bearing generators and elastic coupling for two bearing generators.
2. The generator shall be rated for 40°C ambient industry standard. Class of insulation shall be NEMA Class H. The voltage regulation shall be plus or minus 0.5% from no load to full load with plus or minus 5% speed change and a 15°C. rise in ambient. The generator voltage dip from no load to full load shall not exceed 25%.
3. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.
4. Provide 120 volt condensation heater in windings.

C. Voltage Regulation
1. The generator shall be equipped with a volts-per-hertz type voltage regulator to maintain voltage within limits specified below:
    a. Stability: 0.5% maximum voltage variation at any constant load from no load to full load.
    b. Regulation: 4% maximum voltage deviation between no load steady state and full load steady state.
    c. Transient: 4% seconds maximum voltage recovery time with application or removal of 0.8 power factor full load.
2. The generator shall be equipped with reactive droop compensation or reactive differential compensation.

D. Generator full main line circuit breakers.
1. A main line circuit breaker shall be supplied to protect the generator and controls from overloads and/or short circuits in the load. It shall be rated as indicated on the drawings. Breakers shall comply with UL 489 and NEMA AB-3.

E. Start and Stop Controls
1. Automatic starting and stopping controls shall be furnished to start the engine automatically when the normal electrical power fails or falls below specific limits and to stop the engine automatically after the normal power supply resumes. The signal for starting or stopping the engine shall be sensed through an auxiliary contact in the automatic transfer switch. The controls shall be capable of operating at 50% of normal DC system supplied voltage.

a. Provide a supervised generator start/stop control circuit per NFPA.

2. The cranking cycle shall be initiated by manual start, loss of normal power at any transfer switch clock exerciser, or the manually operated test switch at each ATS.

3. Crank control and the time delay relays shall provide a minimum of 4 crank attempts of at least 7 seconds each, separated by appropriate rest periods. A sensing device shall automatically disconnect the starting circuit when the engine has started. If the engine has not started at the completion of the starting program, the overcrank signal shall indicate. The engine starting controls shall be locked out and no further starting attempts shall take place until the overcranking device has been manually reset.

4. A selector switch shall be incorporated in the automatic engine start and stop controls. It shall include an "off" position that prevents manual or automatic starting of the engine; a "manual" position that permits the engine to be started manually by the pushbutton on the control cabinet and run unloaded; an "automatic" position that readies the system for automatic start or stop on demand or the automatic load transfer switches or of the programmed exerciser.

5. A remote manual stop station similar to a break-glass station shall be provided at the location indicated on the drawings and shall be tied into the engine controls to stop the engine when activated. Provide laminated plastic label with 1/4" minimum engraved letters to read "EMERGENCY GENERATOR SHUTDOWN". Background to be red and core to be white. Exterior installations shall be NEMA 3R enclosure.

F. Instrumentation

1. Local engine control and safety panel shall be provided, containing the following:

a. Automatic remote start capability.

b. "Manual-Off-Auto" switch.

c. Controls to shut down and lock out the prime mover under the following conditions: failure to start after specified cranking time, overspeed, low lubricating oil pressure, high engine temperature and operation of remote manual stop station.

d. Battery powered individual alarm indication to annunciate visually at the control and safety panel the occurrence of any condition itemized below; contacts or circuits for a common audible alarm signaling locally and remotely (to SCADA) the occurrence of any itemized conditions listed below. Test switch shall be provided to test the operation of all lamps.

1) Indicator Function, Level 1 (At Battery Voltage):

	Control Panel Mounted Visual Indication	Shutdown of EPS	SCADA
a) Overcrank	X	X	X
b) Low Water Temp. < 70°F (21°C)	X		X
c) High Engine Temp. Pre-alarm	X		X
d) High Engine Temp.	X	X	X
e) Low Lube Oil Pressure Pre-alarm	X		X
f) Low Lube Oil Pressure	X	X	X
g) Overspeed	X	X	X
h) Low Fuel Main Tank	X		X
i) EPS Supplying Load	X		X
j) Control Switch Not In Auto Pos.	X		X
k) Battery Charger Malfunctioning	X		X
l) Low Voltage in Battery	X		X
m) Lamp Test	X		X
n) Contacts for Local & Remote			X
o) Common Alarm	X		X
p) Audible Alarm Silencing Switch			
q) Remote Emergency Stop	X		X

r) Ground Fault Indication (400KW and greater)	X		X
s) Fuel in containment	X		X

2) Controls to shutdown the prime mover upon removal of initiating signal or manual emergency shutdown.
3) A.C. voltmeter with selector switch off position and positions for phase to phase and phase to neutral.
4) A.C. ammeter with selector switch with positions for each phase.
5) Frequency meter -- digital electronic type.
6) Voltage adjusting to allow plus or minus 5% voltage adjustment.
7) Manual reset circuit breaker.
8) Water temperature gauge.
9) Manual stop/start control.
10) Elapsed time meter.
11) Panel lights.
12) Indicator lights for signals from engine instrument panel.
13) Light to indicate switch has been left in the "off" position.
14) Light to indicate remote start.

2. All instruments, controls, and indicating lights shall be properly identified. All wires shall be individually identified and must agree with the wiring diagram provided. All wiring shall be harnessed or flexibly enclosed. Terminals on all terminal blocks shall be individually identified. All instrumentation must be isolated from engine generator set vibration.

G. Enclosures and Connections:
1. All electrical enclosures, i.e., terminal cabinets, wire ways, circuit breaker enclosures, etc., shall be of adequate size to provide minimum bending radius as required by the NEC and measured from the terminals directly to the opposite wall of the enclosure, for the size conductor actually terminated within or passing through the enclosure.
2. All factory provided enclosures shall have gasket and finish appropriate for the environment in which the unit is to be mounted. All wiring, wiring harness, etc., shall be protected from the elements, such as direct sunlight, moisture, etc. or shall be UL listed for direct exposure to the applicable elements. Include written documentation of the above with the shop drawing submittal.

H. Provide flexible fuel connections at supply at return piping. Flexible hoses shall be steel reinforced type. Provide solenoid valve in series with gate valve in supply line. Solenoid valve shall be powered from generator batteries and shall be open only when generator is running.

2.2 TRANSFER SWITCH(ES)

A. Transfer switch (es) shall be rated at not less than as indicated on the drawings at rated voltage. Transfer switch (es) shall be rated and marked for total system load.

B. Transfer switch (es) serving 480V three phase four wire loads shall be four poles with a switched neutral. Neutral contacts must be on the same shaft as the associated main contacts and have the same continuous current rating and withstand current rating. Neutral contacts shall break last and make first.

C. Transfer switch (es) shall be the automatic, open-transition type switch.

D. Transfer switch (es) shall be floor or wall mounted, as noted, in a NEMA 3R enclosure. Enclosure shall have hinged door with three point latching and provisions for pad locking or factory installed key locking enclosure door.

E. Operation shall be inherently double-throw whereby all contacts move simultaneously. Electrical spacing shall be equal to or exceed those listed in Table 15.1 of UL-1008. Only those main contact structures specifically designed for transfer switch service shall be acceptable. An overload or short circuit shall not cause the switch to go to a neutral position. A manual operating handle shall be provided. All main

contacts shall be silver alloy type protected by arc quenchers and, for switches rated 600 amps and larger, by arcing contacts. Operating transfer time shall be 1/10 second or less on switches rated 600 amps and above.

F. All switch and contacts, coils, springs and control elements shall be removable from the front of the transfer switch without removal of the switch panel from the enclosure and without disconnecting power conductors or drive linkages. Control and sensing relays shall be continuous duty industrial type with minimum contact rating of ten amps.

G. Transfer switch shall be rated to withstand in RMS symmetrical amperes not less than the available symmetrical RMS amperes when protected by the circuit protective device on the line side of the transfer switch. Withstand rating of switch shall be based on switch contacts not welding under fault conditions. Provide switch with current limiting fuses to increase current withstand rating when switch is not rated for fault duty.

H. The control panel for each automatic transfer switch shall contain the following accessories:
1. Adjustable 0.5 to 6 second time delay on starting of EPS to override momentary power dips and interruptions of the normal services. Time delay shall be factory set at 1 second.
2. Time delay on transfer to emergency adjustable from 0 to 60 seconds, factory set at 0 seconds.
3. Test switch on enclosure door to simulate failure of the normal power source. ATS shall transfer load to the EPS.
4. Push button to bypass time delay on re-transfer to normal.
5. Close differential voltage sensing shall be provided on all phases of the normal power supply. The pickup voltage shall be adjustable from 85% to 100% of nominal and the dropout voltage shall be adjustable from 75% to 98% of the pickup value. The transfer to emergency will be initiated upon reduction of normal source to 85% of nominal voltage and re-transfer to normal shall occur when normal source restores to 95% of nominals.
6. Independent single phase voltage and frequency sensing of the emergency source. The pickup voltage shall be adjustable from 85% to 100% of nominal. Pickup frequency shall be adjustable from 90% to 100% of nominal. Transfer to emergency upon normal source failure when emergency source voltage is 90% or more of nominal and frequency is 95% or more of nominal.
7. A time delay on re-transfer to normal source. The time delay shall be automatically bypassed if the emergency source fails and normal source is available. The time delay shall be field adjustable from 0 to 25 minutes and factory set at 15 minutes.
8. An unloaded running time delay for emergency generator cool-down, factory set at 5 minutes.
9. Provide open/delayed transition type automatic transfer switch. In-phase transition is not acceptable.
10. Pilot light for indicating switch in normal position (include fuses and auxiliary contact).
11. Pilot light for indicating switch in emergency position (include fuses and auxiliary contact).
12. An exerciser for exercising standby power plant on a weekly basis shall be provided in the transfer switch. Exerciser shall be set to exercise standby plant for one half hour per week under load. Time of plant exercise shall be set in field. Exerciser timer shall have reserve power back-up, either by battery or spring-wound clock, to ride through power outages to the switch.
13. Auxiliary contact (gold plated) which closes when normal source fails. (Closed after override delay of 0.5 to 6 seconds).
14. Auxiliary contact (gold plated) which opens when normal source fails. (Opens after override delay of 0.5 to 6 seconds).
15. Auxiliary contacts on same shaft as main contacts (closed on normal.)
16. Auxiliary contacts on same shaft as main contacts (closed on emergency).

2.3 FUEL SUPPLY

A. A double wall fuel storage tank with sufficient fuel capacity to allow the EPS to operate continuously at full rated load for 24 hours shall be located in the skids below the generator set, and shall be complete with all piping and fittings connected. No galvanized material shall be used in the tank or fueling system. The tanks shall be vented to atmosphere. A fuel level gauge shall be located as indicated on the drawings. The system shall be supplied to deliver an adequate amount of fuel to the engine from the

storage tank. Pipe sizes shall be no smaller than the minimum recommended by the engine manufacturer to avoid fuel flow restriction. The engine supply and return line shall be equipped with a length of flexible fuel lines, unions, and gate valves. No copper lines are acceptable.

B. Provide a set of normally open contacts in fuel level indicating "LOW FUEL" in fuel tank. Interconnect with remote low fuel alarm specified earlier in this section.

C. Provide leak detection monitoring system with a set of normally open contacts in secondary compartment of double wall tank space to indicate presence of fuel.

D. Provide audible/visual alarm so that if tank is above 90% full, alarm sounds. Provide silence switch and engraved sign reading "DISCONTINUE FILLING IF ALARM SOUNDS."

PART 3 - EXECUTION

3.1 EPS DELIVERY

A. Delivery of the EPS equipment shall be coordinated with the owner and the installing contractor.

3.2 TESTING

A. Submit verification letter to Engineer indicating successful completion of sequence of operations testing and certification that all functions are operational. Letter to request load testing approval and schedule of proposed test. Prior to load test, written approval must be provided by Engineer. Representatives of the generator and transfer switch shall be present. The local authority having jurisdiction shall be given advance notification of the time of the final test in order that he may witness the tests.

B. A failure of any test or any component during a test will require a complete retest program at no additional cost to the Owner.

C. All fuel, lubricants, and other consumables for testing shall be supplied by the building contractor.

D. An on-site acceptance test shall be conducted as a final approval test for all Emergency Power Supply Systems.
1. The test shall be conducted after completion of the installation with all EPSS accessory and support equipment in place and operating.
2. Test Results. The EPSS shall perform within the limits specified in the standard NFPA-110, level I.
3. The on-site installation test shall be conducted as required by the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.

3.3 O&M MANUALS

A. At least three sets of an instruction manual(s) for all major components of the EPS shall be supplied by the Manufacturer(s) of the EPS and shall contain:
1. A detailed explanation of the operation of the system.
2. Instruction for routine maintenance.
3. Detailed instructions for repair of the EPS and other major components of the EPS.
4. Pictorial parts list and part numbers.
5. Pictorial and schematic electrical drawings of wiring systems, including operation and safety devices, control panels, instrumentation and annunciators.

3.4 IDENTIFICATION

A. Refer to the ELECTRICAL IDENTIFICATION section of these specifications for identification requirements.

3.5 TRAINING

A. The generator manufacturer shall provide 4 hours of on-site training for owners personnel.

END OF SECTION

SECTION 263214

ENGINE DRIVEN EMERGENCY POWER SUPPLY SYSTEM INSTALLATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The work required under this section of the specifications consists of the installation of the complete Engine Driven Emergency Power Supply System. All materials, conduit and wiring, which are an integral part of this system shall be provided under this section of the specifications.

B. Definition: The Emergency Power Supply System (EPSS) shall consist of one or more engine driven generator sets, each of which contains an engine directly coupled to an electric generator, together with the necessary switchgear, controls, accessories, transfer devices, and fuel supply to provide electric power for the duration of any failure of the normal power supply.
   1. Automatic Transfer Switch (ATS): An automatic transfer switch is self-acting equipment for transferring one or more load conductor connections from one power source to another.

1.3 QUALITY ASSURANCE

A. The following specifications and standards are incorporated into and become a part of this specification by reference.
   1. National Fire Protection Association (NFPA):
      a. NFPA-37 Combustion Engines
      b. NFPA-70 National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701 and 702,
      c. NFPA-99 Essential Electrical Systems for Health Care Facilities
      d. NFPA-110 Emergency and Stand-By Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement.
   2. Institute of Electrical and Electronics Engineers (IEEE) Standards:
      a. IEEE 446 IEEE Recommended Practices for Emergency and Standby Power Systems for commercial and industrial applications.
      b. IEEE 472 Voltage Surge Withstand Capabilities
   3. National Electric Manufacturers Association (NEMA) Standards:
      a. NEMA MG1-1998 part 32. Alternator shall comply with the requirements of this standard.
      b. ICS1-109 Test and Test Procedures for Automatic Transfer Switches
      c. ICS 10-2005 Part 1 A.C. Automatic Transfer Switch
   4. Underwriters Laboratories Inc. (UL) Publications:
      a. UL 1008 Automatic and Non-Automatic Transfer Switches
      b. UL508. The entire control system of the generator set shall be UL 508 listed and labeled.
      c. UL142 – Sub-base Tanks
      d. UL 1236 – Battery Chargers
      e. UL2200 – The generator set shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed.
   5. American National Standards Institute (ANSI):
      a. C37.90a Voltage Surge Withstand Capability
   6. The control system for the generator set shall comply with the following requirements.
      a. CSA C22.2, No. 14 – M91 Industrial Control Equipment.

b. EN50082-2, Electromagnetic Compatibility – Generic Immunity Requirements Part 2: Industrial
c. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
d. FCC Part 15, Subpart B.
e. IEC8528 part 4. Control Systems for Generator Sets
f. IEC Std 801.2, 801.3 and 801.5 for susceptibility, conducted and radiated electromagnetic emissions.

7. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation and service, in accordance with ISO 9001.

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable:
1. Engine Driven Generator Sets:
a. Caterpillar
b. Cummins/Power Generation
c. MTU
2. Transfer Switches:
a. ASCO
b. Russelectric
c. Caterpillar/ABB TrueONE Series with ZTG-T Controller
d. Cummins/Power Generation OTEC Series with 40 – 01 Controller
3. Sub-Base Fuel Tanks by engine manufacturer or approved 3rd party supplier.

C. Equipment Dimensions:
1. Dimensions indicated on the drawings are maximum allowable and shall not be exceeded. Where equipment of acceptable manufacturers listed exceeds the maximum dimensions, products of such manufacturers shall not be acceptable.

D. Coordination:
1. The installing contractor shall review shop drawings submitted under this and other sections, as well as other divisions, to insure coordination between work required among different trades. Coordinate the installation sequence with other contractors to avoid conflicts and to provide the fastest overall installation schedule. Coordinate installation with architectural and structural features, equipment installed under other sections of the specifications, and electrical equipment to insure access and to insure clearance minimums are provided.

PART 2 - PRODUCTS

2.1 ENGINE DRIVEN EMERGENCY POWER SUPPLY (EPS)

A. Engine
1. Each engine driven emergency power supply (EPS) shall be an internal combustion diesel driven prime mover. The generator sets shall have the ratings as indicated on the drawings.
2. The EPS and automatic transfer switch are owner furnished-contractor installed.

B. Start and Stop Controls
1. Automatic starting and stopping controls shall be furnished to start the engine automatically when the normal electrical power fails or falls below specific limits and to stop the engine automatically after the normal power supply resumes. The signal for starting or stopping the engine shall be sensed through an auxiliary contact in the automatic transfer switch. The controls shall be capable of operating at 50% of normal DC system supplied voltage.
a. Provide a supervised generator start/stop control circuit per NFPA.
2. A remote manual stop station similar to a break-glass station shall be provided at the location indicated on the drawings and shall be tied into the engine controls to stop the engine when

activated. Provide laminated plastic label with 1/4" minimum engraved letters to read "EMERGENCY GENERATOR SHUTDOWN". Background to be red and core to be white. Exterior installations shall be NEMA 3R enclosure.

C. Instrumentation

1. Local engine control and safety panel shall be provided, containing the following:
   a. Automatic remote start capability.
   b. "Manual-Off-Auto" switch.
   c. Controls to shut down and lock out the prime mover under the following conditions: failure to start after specified cranking time, overspeed, low lubricating oil pressure, high engine temperature and operation of remote manual stop station.
   d. Battery powered individual alarm indication to annunciate visually at the control and safety panel the occurrence of any condition itemized below; contacts or circuits for a common audible alarm signaling locally and remotely (to SCADA) the occurrence of any itemized conditions listed below. Test switch shall be provided to test the operation of all lamps.
      1) Indicator Function, Level 1 (At Battery Voltage):

	Control Panel Mounted Visual Indication	Shutdown of EPS	SCADA
a) Overcrank	X	X	X
b) Low Water Temp. < 70°F (21°C)	X		X
c) High Engine Temp. Pre-alarm	X		X
d) High Engine Temp.	X	X	X
e) Low Lube Oil Pressure Pre-alarm	X		X
f) Low Lube Oil Pressure	X	X	X
g) Overspeed	X	X	X
h) Low Fuel Main Tank	X		X
i) EPS Supplying Load	X		X
j) Control Switch Not In Auto Pos.	X		X
k) Battery Charger Malfunctioning	X		X
l) Low Voltage in Battery	X		X
m) Lamp Test	X		X
n) Contacts for Local & Remote			
o) Common Alarm	X		X
p) Audible Alarm Silencing Switch			
q) Remote Emergency Stop	X		X
r) Ground Fault Indication (400KW and greater)	X		X
s) Fuel in containment	X		X

      2) Controls to shutdown the prime mover upon removal of initiating signal or manual emergency shutdown.

2. All wires shall be individually identified and must agree with the wiring diagram provided. All wiring shall be harnessed or flexibly enclosed. Terminals on all terminal blocks shall be individually identified. All instrumentation must be isolated from engine generator set vibration.

D. Enclosures and Connections:

1. All electrical enclosures, i.e., terminal cabinets, wire ways, circuit breaker enclosures, etc., shall be of adequate size to provide minimum bending radius as required by the NEC and measured from the terminals directly to the opposite wall of the enclosure, for the size conductor actually terminated within or passing through the enclosure.

2. All wiring, wiring harness, etc., shall be protected from the elements, such as direct sunlight, moisture, etc. or shall be UL listed for direct exposure to the applicable elements. Include written documentation of the above with the shop drawing submittal.

2.2 TRANSFER SWITCH(ES)

A. Transfer switch (es) shall be rated at not less than as indicated on the drawings at rated voltage. Transfer switch (es) shall be rated and marked for total system load.

B. Transfer switch (es) serving 480V three phase four wire loads shall be four poles with a switched neutral. Neutral contacts must be on the same shaft as the associated main contacts and have the same continuous current rating and withstand current rating. Neutral contacts shall break last and make first.

C. Transfer switch (es) shall be the automatic, open-transition type switch.

D. Transfer switch (es) shall be floor or wall mounted, as noted, in a NEMA 3R enclosure.

2.3 FUEL SUPPLY

A. A double wall fuel storage tank with sufficient fuel capacity to allow the EPS to operate continuously at full rated load for 24 hours shall be located in the skids below the generator set and shall be complete with all piping and fittings connected. The contractor shall provide all fuel for testing.

PART 3 - EXECUTION

3.1 EPS INSTALLATION

A. The plant shall be anchored to a concrete base whose overall dimensions shall exceed the outside dimensions of the plant base by 12" in each direction. Base depth shall be 12". Reinforce base with No. 5 bars 12" on center in both directions. Use not less than 6-3/4" galvanized anchor bolts.
1. Concrete base shall be isolated from adjacent concrete paving or floor slab.

B. The plant shall be on a welded steel base with vibration isolators. Isolators designed specifically for this application, mounted on rubber plates to block high frequency vibrations shall be provided. Isolators shall be designed for the seismic zone requirements in the area where the generator is installed.

C. Provide a laminated sign at the building service entrance equipment indicating type and location of on-site emergency power sources.

D. For exterior installations, the EPS shall be provided in outdoor, weatherproof housing with removable panels for access to equipment. Color shall be as selected by the Engineer. The starting batteries shall be rack mounted within the housing. Provide manufacturer’s standard maintenance switched lighting system within housing. Enclosure shall be aluminum rated for 150 mph winds.

E. Provide sound attenuating enclosure to provide for 74 db at 7 meters.

F. Extend 120 volt and/or 208 and/or 240 volt emergency power circuits for fuel pump and cold weather starting aids from the building wiring system.

3.2 TRANSFER SWITCH INSTALLATION

A. Lace and group conductors installed in transfer switch with nylon tie straps. Only one conductor shall be installed under terminals. Form and train conductors in enclosure neatly parallel and at right angles to sides of box. Uninsulated conductor shall not extend beyond one-eights inch from terminal lug. Conductors shall be installed such that no stresses are transferred to terminal lugs.

B. Mounting and Support

1. Mounting
   a. Enclosure shall be secured to structure by a minimum of eight (8) devices. A 1.5 inch minimum diameter round washer shall be used between head of screw or bolt and enclosure.
   b. Enclosures shall be mounted where indicated on the drawings or specified herein. Support from the structure with fastening device specified.
   c. Attach enclosure directly to masonry, concrete, or wood surfaces.
   d. Mount enclosure on metal channel (strut), which is connected to structure with fastening device specified, for installations on steel structure, sheet metal equipment enclosure, or sheet rock walls.
   e. Do not splice conductors in enclosure. Where required, install junction box or wireway adjacent to transfer switch and splice or tap conductors in box. Refer to number of conductors in a conduit limitation defined in the WIRES AND CABLES section of the specifications and do not exceed.
   f. Conductors not terminating in transfer switch shall not extend through or enter transfer switch enclosure.
   g. For interior installations install push-in knock-out closure plugs in any unused knock-out openings. For exterior installations provide NEMA 3R hole seals.
   h. Free standing transfer switch (es) shall be installed on a four inch high concrete pad, with horizontal base dimension exceeding base dimension of switch by three inches.
   i. Cleaning and Adjustment
      1) After completion, clean the interior and exterior of dirt, paint and construction debris.
      2) Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

3.3 TESTING

A. Submit verification letter to Engineer indicating successful completion of sequence of operations testing and certification that all functions are operational. Letter to request load testing approval and schedule of proposed test. Prior to load test, written approval must be provided by Engineer. Representatives of the generator and transfer switch shall be present. The local authority having jurisdiction shall be given advance notification of the time of the final test in order that he may witness the tests.

B. A failure of any test or any component during a test will require a complete retest program at no additional cost to the Owner.

C. All fuel, lubricants, and other consumables for testing shall be supplied by the installing contractor.

D. An on-site acceptance test shall be conducted as a final approval test for all Emergency Power Supply Systems.
   1. The test shall be conducted after completion of the installation with all EPSS accessory and support equipment in place and operating.
   2. Test Results. The EPSS shall perform within the limits specified in the standard NFPA-110, level I.
   3. The on-site installation test shall be conducted as required by the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.

3.4 IDENTIFICATION

A. Refer to the ELECTRICAL IDENTIFICATION section of these specifications for identification requirements.

END OF SECTION

SECTION 263215

ENGINE DRIVEN EMERGENCY POWER SUPPLY SYSTEM TRAILER MOUNTED

PART 1 - GENERAL

1.1 SUMMARY

A. The work required under this section of the specifications consists of a complete Engine Driven Emergency Power Supply System mounted on trailer. All materials and devices which are in integral part of this system shall be provided under this section of the specifications.

B. The Emergency Power Supply System (EPSS) shall consist of a Tier 4 Final EPA-certified engine driven generator set for non-road applications, which contains an engine directly coupled to an electric generator, together with the controls, accessories, single wall trailer and fuel supply to provide electric power for the duration of any failure of the normal power supply.

1.2 QUALITY ASSURANCE

A. The following standards are incorporated into and become a part of this specification by reference.

1. National Fire Protection Association (NFPA):
   a. NFPA-37 Combustion Engines
   b. NFPA-70 National Electrical Code
   c. NFPA-110 Emergency and Stand-By Power Systems

1.3 MANUFACTURERS

A. Products of the following manufacturers, which comply with these specifications, are acceptable:

1. Engine Driven Generator Sets:
   a. Caterpillar
2. Single wall trailer
   a. Caterpillar
3. Sub-Base Fuel Tanks:
   a. Pryco
   b. Simplex
   c. Generator Manufacturer

1.4 SUBMITTALS

A. Manufacturer's Product Data:

1. Submit material specifications and installations data for products specified under Products to include:
   1) Engine driven generator sets
   2) Trailer
   3) Sub-base fuel tanks
   4) Accessories

B. QUALITY AND SERVICE:

1. All materials and parts of the EPSS shall be new and unused. Units and components offered under these specifications shall be covered by the manufacturer's warranty for a minimum of five years from date of Owner acceptance of the new machine, a copy of which shall be included in the shop drawings submittal.
2. Submittals will be accepted only on engine driven generator sets which can be properly maintained and serviced without requiring the Owner to stock spare parts or wait longer than twenty-four hours for service. Submittals shall include the nearest location of permanent parts outlet from which parts

may be obtained and written assurance that trained service personnel will be available on twenty-four hour's notice. Units with service centers more than 120 miles from project site will not be accepted.

C. OPERATION & MAINTENANCE MANUALS

1. Include in each set one set of operating, maintenance, and parts manuals covering all components for the EPSS. Each supplier shall provide instructions to the Owner in operation and maintenance of his equipment, both in written form and with on-site personnel for a minimum of eight hours.

1.5 ENGINE

A. The engine driven emergency power supply (EPS) shall be an internal combustion diesel driven prime mover. The generator set shall have the following characteristics:

1. 200 KW Capacity
2. 250 KVA Capacity
3. 480Y/277: 208Y/120V; 240/120V Delta (High Leg): 240/120V (1 phase, 3 wire)
4. 60 Hertz
5. .8 Power Factor
6. 3 Phase
7. 4 Wire

B. The rated net horsepower of the engine at the generator synchronous speed, with all accessories, shall not be less than that required to produce the KW specified in paragraph 1 above. The generator set shall be capable of producing the specified KW (without overload) for the duration of the power outage, under the following ambient conditions:

1. Altitude: 10 feet above mean sea level.
2. Air temperature at engine intake: 104 degrees F.
3. Humidity Range: 10-95 %.

C. Included with the shop drawing submittal shall be the manufacturer's estimate of supply fuel and oil consumption for the engine. The engine shall have an oil filter with replaceable elements, lube oil cooler, and an oil reservoir to which oil can be added while the engine is running.

D. The engine shall be equipped with a suitable governor (engine speed control) to maintain frequency within limit specified below by controlling engine and generator speed. Manufacturer shall indicate in submittal data whether mechanical, hydraulic, electrical, or hybrid governors are provided.

1. Type: Isochronoms: -=/-0.25% maximum
2. Stability: 1/2% maximum steady state frequency variation at any constant load from no load to full load.
3. Regulation: 5% maximum frequency deviation between no-load steady state and full load steady state.
4. Transient: 2 seconds maximum recovery time for maximum motor start.

E. The engine shall be electric start, provided with a solenoid energized motor with either positive engagement or clutch drive to the engine. The engine starting batteries shall be lead-acid batteries with battery rack, battery straps and battery heater. The voltage shall be as called for by the engine manufacturers with quantity of cells as required.

Batteries shall be rack mounted inside the weatherproof housing.

F. A float type battery charger, compatible with the batteries selected, shall be furnished at the engine which shall maintain the starting batteries at full charge. The charging system shall permit charging from either the normal or the emergency power source. Charging system shall come complete with a 20 amp 30’ type SOOW cord/twist-lock plug connection for normal power source charging. It shall have an equalize rate and a float rate charging system. It shall be capable of recharging a discharged battery in 12 hours

while carrying normal loads. The charger shall be equipped with alarm relays as required for remote annunciation equipment.

G. The engine shall be liquid cooled. The type of liquid cooling system shall be unit mounted radiator - consideration shall be given for air temperature rise across the engine in addition to ambient. Minimum capacity shall be rated for 104°F. minimum engine ambient temperature plus air temperature rise across the engine.

1. Provide an electric heater, thermostatically controlled, in the engine coolant system as a cold weather starting aid. Heater shall be for operation on 120 volt single phase A.C. Heater shall maintain 70°F. to 90°F. Heater shall come complete with a 20 amp, 30' type SOOW cord/twist-lock plug connection. Provide isolation valves or quick connect fittings for heater.

H. Air Supply/Exhaust System

1. Cleaner: An air cleaner and silencer shall be furnished, located and mounted as recommended by the engine manufacturer.
2. Exhaust: An exhaust system of suitable size, configuration, and material in accordance with engine manufacturer's recommendations shall connect the exhaust outlet of the engine to a silencer. The type of silencer shall meet the requirements of engine manufacturers and shall be critical. The silencer shall be located on top of the outdoor enclosure.

I. The engine instrument panel shall be mounted at the engine and shall contain instruments required by NFPA 110.

J. The engine shall be Tier 4 Final EPA-certified for non-road applications.

1.6 GENERATOR

A. The generator shall be an engine-driven single or two bearings type, synchronous, brushless, and conforming to applicable standards.

B. The generator shall be rated for 40°C. ambient. Class of insulation shall be NEMA Class F. The voltage regulation shall be plus or minus 2% from no load to full load with plus or minus 5% speed change and a 15°C. rise in ambient. The generator voltage dip from no load to full load shall not exceed 12%.

C. The generator shall be capable of sustaining at least 250% of rated current for at least ten (10) seconds under a three phase symmetrical short by inherent design with a permanent magnetic excitation system. A resettable line sensing circuit breaker shall be furnished which protects the generator from damage due to its own high current capability. This breaker shall not trip within the ten seconds specified above to allow selective tripping of downstream fuses or circuit breakers under a fault condition.

D. Voltage Regulation

1. The generator shall be equipped with a volts-per-hertz type voltage regulator to maintain voltage.

E. Generator full main line circuit breaker

1. A main line circuit breaker shall be supplied to protect the generator and controls from overloads and/or short circuits in the load. It shall be rated at 800 amps, 3 pole, 4 wire, with ground termination.

F. Start and Stop Controls

1. The cranking cycle shall be initiated by manual start.
2. Crank control and the time delay relays shall provide a minimum of 4 crank attempts of at least 7 seconds each, separated by appropriate rest periods.

3. A selector switch shall be incorporated in the automatic engine start and stop controls. It shall include an "off" position that prevents manual starting of the engine; a "manual" position that permits the engine to be started manually by the pushbutton on the control cabinet and run unloaded.
4. A remote manual stop station similar to a break-glass station shall be provided at on the exterior housing and shall be tied into the engine controls to stop the engine when activated. Provide laminated plastic label with 1/4" minimum engraved letters to read "EMERGENCY GENERATOR SHUTDOWN". Background to be red and core to be white.

G. Enclosures and Connections:

1. All electrical enclosures, i.e, terminal cabinets, wireways, circuit breaker enclosures, etc., shall be of adequate size to provide minimum bending radii as required by the NEC for the size conductor actually terminated within or passing through the enclosure.
2. All factory provided enclosures shall have gasketing and finish appropriate for the environment in which the unit is to be mounted. All wiring, wiring harness, etc., shall be protected from the elements, such as direct sunlight, moisture, etc. or shall be UL listed for direct exposure to the applicable elements. Include written documentation of the above with the shop drawing submittal.

H. Voltage Selector Switch

1. The generator shall be furnished with a four-position switch to select the output voltage. The switch shall be located within the housing. Provide the following voltage configuration.

Position	Voltage
1	480Y/277V, 3 phase, 4 wire Wye
2	208Y/120V, 3 phase, 4 wire Wye
3	240/120V, 3 phase, 4 wire High-Leg Delta
4	240/120V, 1 phase, 3 wire

2. Label all switch positions.
3. Provide warning sign against changing voltages while generator is running.

1.7 FUEL CONNECTIONS

A. Provide flexible fuel connections at supply at return piping. Flexible hoses shall be steel reinforced type. Provide solenoid valve in series with gate valve in supply line. Solenoid valve shall be powered from generator batteries and shall be open only when generator is running.

1.8 FUEL STORAGE TANK

A. 250 gallon (minimum) double wall fuel storage tank with shall be located in the skids below the generator set, and shall be complete with all piping and fittings connected. No galvanized material shall be used in the tank or fueling system. The tanks shall be vented to atmosphere. A fuel level gauge shall be located on the outside of the generator enclosure. A leak detection monitoring system shall be provided. The system shall be supplied to deliver an adequate amount of fuel to the engine from the storage tank. Pipe sizes shall be no smaller than the minimum recommended by the engine manufacturer to avoid fuel flow restriction. The engine supply and return line shall be equipped with a length of flexible fuel lines, unions, and gate valves. No copper lines are acceptable. The fuel tank shall be sized for 24 hour continuous run time at stand-by rating of the generator.

B. Provide a set of normally open contacts in fuel level indicating system of fuel tank. Interconnect with remote low fuel alarm specified earlier in this section.

1.9 TRAILER

A. Generator shall be mounted on a Department of Transportation compliant trailer with the following characteristics:

1. Dual Dexter-type 5000 lbs. axle
2. 3" eye-pintle hitch
3. Top wind -5000LBS. tongue jack/sandshoe
4. DOT wiring enclosed in ½" steel steel conduit
5. 7 way round trailer plug
6. Rear LED brake lights (pop-in style)
7. Rear stabilizer jacks.
8. ST 205/75-R15 load range C trailer rated tires with steel 15 X 6, 6 bolt wheels.
9. Electric brakes with breakway system.
10. (2) 5/16" x 30" safety chains with 3/8" hook.
11. Integral double wall 60 gallon fuel tank.
12. Leak detection monitoring system.
13. Manual fuel gauge.
14. Fuel fill & vent
15. Fuel pick up and return ports & rails-generator specific
16. Mounting rails-generator specific
17. Prime & paint semi-gloss black.
18. Weight bearing fenders over wheels
19. Lockable cable/tool storage box (30" X 36" X 18") with extended tonnage.

1.10 PORTABLE CORD CONNECTIONS

A. Equip generator breaker with two sets, thirty foot, portable cables with a camlok (female) on one end.

1. 400 amp camlock (female) shall match 400 amp male receptacle Crouse-Hinds Camlok (male) receptacle mounted in the docking station.
2. 200A camlok (female) connection shall match 200A Camlok (male) receptacle mounted in the docking station.
3. Coordinate the plug with the cable diameter.
4. The ground conductor shall be ½ the size of the phase cable.

1.11 EXTERIOR HOUSING

A. The EPS shall be provided in an outdoor, weatherproof, sound attenuated (72dBA at 23 ft), painted steel housing with removable panels for access to equipment. Color shall be the manufacturer's standard color. The starting batteries shall be rack mounted within the housing.

B. Provide extra-duty portable cord connection with plug for power to the battery charger and block heater. Field coordinate receptacle connection. Furnish separate cords for each. 30' minimum length.

C. Provide extra-duty portable cord connection for start command. Field coordinate receptacle connection. 30' minimum length.

END OF SECTION

SECTION 266500

ELECTRICAL EQUIPMENT ACCEPTANCE TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The work required under this section of the specifications consist of the start-up testing and inspection of the electrical equipment designated within. All labor and testing equipment which is required shall be provided under this section of the specifications.

1.3 GENERAL

A. The Contractor shall perform the tests as outlined below to insure system acceptance.

B. When the tests and inspections have been completed, a label shall be attached to all devices tested. The label shall provide the name of the testing company, the date the tests were completed, and the initials of the engineer who performed the tests.

C. The tests shall insure that the equipment is operational and functioning within industry standards and manufacturer's tolerances. Forward all test reports to the Architect at least two weeks prior to the project final inspection for review. Reports shall be bound as required by Division 01 of this specification.

1.4 QUALITY ASSURANCE

A. The testing and inspection shall comply with all applicable sections of the following codes and standards:
   a. American National Standards Institute - ANSI
   b. American Society for Testing and Materials - ASTM
   c. Association of Edison Illuminating Companies - AEIC
   d. Institute of Electrical and Electronics Engineers - IEEE
   e. Insulated Power Cable Engineers Association - IPCEA
   f. International Electrical Testing Association - NETA Acceptance Testing Specifications
   g. National Electrical Code - NEC
   h. National Electrical Manufacturers Association - NEMA
   i. National Fire Protection Association - NFPA
   j. State and Local Codes and Ordinances

B. The inspection and testing shall comply with the project plans and specifications as well as with the manufacturer's drawings, instruction manuals, and other applicable data for the apparatus tested.

A. The contractor shall perform routine insulation-resistance, continuity, and rotation tests for all distribution and utilization equipment prior to and in addition to tests performed by the testing firm specified herein.

B. The contractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the specific power requirements.

C. The contractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.

D. The testing firm shall notify the Engineer prior to commencement of any testing.

E. Any system, material or workmanship which is found defective on the basis of acceptance tests shall be reported to the Engineer.

F. The testing firm shall maintain a written record of all tests and, upon completion of project, shall assemble and certify a final test report.

1.6 SAFETY AND PRECAUTIONS

A. Safety practices shall comply with applicable state and local safety orders as well as with the Occupational Safety and Health Act of 1970 (OSHA). Compliance with the National Fire Protection Association standard NFPA 70E and the Accident Prevention Manual for Industrial Operations of the National Safety Council shall be observed.

B. Tests shall only be performed on apparatus which is de-energized. The testing company's lead test engineer for the project shall be a designated safety representative and shall supervise testing observations and safety requirements. Work shall not proceed until he has determined that it is safe to do so.

C. Power circuits shall have conductors shorted to ground by a hotline grounded device approved for the purpose. Warning signs and protective barriers shall be provided as necessary to conduct the tests safely.

1.7 REPORTS

A. The test report shall include the following sections:
1. Scope of testing
2. Equipment tested
3. Description of test
4. Test results
5. Conclusions and recommendations
6. Appendix, including test forms

B. Each piece of equipment shall be recorded on a data sheet listing the condition of the equipment as found and as left. Included shall be recommendations for any necessary repair and/or replacement parts. The data sheets shall indicate the name of the contractor who tested the equipment and the date of the test completion.

C. Record copies of the completed test report shall be submitted no more than 30 days after completion of the testing and inspection.

1.8 TEST EQUIPMENT

A. All test equipment shall be in good mechanical and electrical condition. All field instruments shall have been calibrated within six months of the testing date, and dated calibration labels shall be visible on the testing equipment. Submit calibration certification in the final report.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials are specified under other sections of this specification. All testing equipment required shall be provided under this section of the specifications.

PART 3 - EXECUTION

3.1 EQUIPMENT TO BE TESTED

A. The following equipment shall be tested in accordance with the scopes of work which follow.
1. Dry Type Transformers
2. Low Voltage Switchgear and Switchboards
3. Molded Case Circuit Breakers
4. Automatic Transfer Switches
5. Emergency Power Supply-Engine Driven
6. Grounding System
7. Cables, Low Voltage, 600 Volts Maximum
8. Ground Fault Systems

3.2 DRY TYPE TRANSFORMERS

A. Visual and Mechanical Inspection
1. With case covers removed, inspect transformer core and coil assembly and enclosure interior. Cloth wipe and/or brush major insulating surfaces.
2. Check primary, secondary, and ground connections.
3. Check tap connections and tap changer.
4. Inspect all bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections.
5. Inspect insulators, spacers, and windings.
6. Inspect for adequate electrical clearance.
7. Check base or support insulators, including vibration isolation supports.
8. Check accessory devices for condition and proper operation.
9. Verify that the transformers have been provided with adequate spacing for ventilation.

B. Electrical Tests
1. Insulation Resistance Test: Megger transformer windings high to low and ground, low to high and ground, and high and low to ground.
2. Where auxiliary cooling has been provided, verify proper operation of such equipment.
3. Include measured secondary voltage (line-to-line and line-to-ground) for each transformer in the test report. Verify that the taps on all transformers with primary voltages above 600 volts are set to deliver voltage indicated in the Contract Documents with the system in full operation. Secondary voltage readings, at each transformer, phase to phase neutral, and phase load readings

shall be recorded and tap positions of transformer taps noted. This test shall be conducted with a calibrated voltmeter.

4. Each ground rod installation shall be tested after all connections to ground rods are made before grounding conductor connection is made to the transformer. Ground rod installations shall be tested by "fall of potential" measuring method using ground resistance test meter and two auxiliary electrodes driven into the earth, interconnected through the meter with the ground rod installation being tested.
5. Placement of auxiliary electrodes shall be in accordance with operating instructions of test meter, but in no case shall auxiliary current electrodes be placed within 70' of the grounding system being tested. Test data shall indicate placement of auxiliary electrodes with respect to systems being tested, date readings were taken and lowest resistance recorded.

3.3 LOW VOLTAGE SWITCHGEAR AND SWITCHBOARDS

A. Visual and Mechanical Inspection
1. Verify that the contractor has cleaned enclosure interiors of accumulated dust, dirt, oil films, and other foreign materials.
2. Inspect all electrical and mechanical components for condition and any evidence of defects or failure.
3. Check for proper travel and alignment of any drawout or plug-in circuit breakers.
4. Check breaker connections to bus.
5. Inspect bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections.
6. Inspect for missing or loose hardware or accessories.
7. Inspect ground bus connections.
8. Operate key and door interlock devices to assure proper operation.

B. Electrical Tests
1. Insulation Resistance Test: Megger main secondary bus and feeder circuits phase-to-phase and phase-to-ground.
2. Energize any space heater circuits to insure proper operations.

C. Check phase rotation with a Biddle phase rotation meter.

D. Instruments and Meter Tests
1. Inspect panel mounted instruments and meters. Clean and check for calibration accuracy. Make minor adjustments as necessary.

3.4 MOLDED CASE CIRCUIT BREAKERS

A. Visual and Mechanical Inspection
1. Inspect cover and case, and check for broken or loose terminals.
2. Operate breaker to check operation.

B. Electrical Tests (400 ampere frame and larger)
1. Insulation Resistance Test: Megger main poles of breaker pole-to-pole, from each pole to ground, and across the open contacts of each pole.
2. Contact Resistance Test: Ductor across main pole contacts with breaker closed and latched to check for good, low resistance contact.
3. Test overcurrent trip device and calibrate [to settings provided by the engineer.] Where primary injection testing is specified, test each pole of the breaker individually. Data shall be compared with manufacturer's published data.
    a. All trip units shall be tested by primary injection.

b. Static overcurrent trip devices shall be tested per manufacturer's instructions.
c. Test for minimum pick-up current.
d. Apply 300% of pick-up current and measure time necessary to trip breaker (long time delay).
e. Where short time delay characteristics are provided, test short time pick-up and delay.
f. Test instantaneous trip by passing current sufficiently high to trip breaker instantaneously.
g. Where ground fault protection is provided, test ground fault pick-up and delay.
h. Check reset characteristics of trip unit.

4. Electrically test any auxiliary devices such as shunt trips, undervoltage trips, alarm switches, and auxiliary switches.

3.5 AUTOMATIC TRANSFER SWITCHES

A. Visual and Mechanical Inspection
1. Verify that contractor has cleaned enclosure interiors and all components of accumulated of dust, dirt, oil films, and other foreign material.
2. Inspect all electrical and mechanical components for condition and any evidence of defect or failure.
3. Perform inspection checks on individual components as recommended by the manufacturer.
4. Inspect connections for looseness. The electrical contractor shall torque wrench tighten or remake any questionable connections.
5. Inspect for missing or loose hardware or accessories.
6. Check for proper mechanical operation and lubricate, as necessary.
7. Check transfer mechanism for alignment and friction-free operation. Lubricate, as necessary.
8. Check all connecting wiring for condition.

B. Electrical Tests
1. Use test switch, when available, to check the electrical operation of the transfer switch.
2. When a test switch is not available, a failure of the normal source power will be simulated by disconnecting a voltage sensing lead.
3. Test and adjust all sensing relays, and other devices specifically associated with the transfer switch.
4. Contact Resistance Test: Ductor across main pole contacts of power switching circuit breakers, switches or contactor contacts with device closed and latched to check for good, low resistance contact.

3.6 EMERGENCY POWER SUPPLY-ENGINE DRIVEN

A. Visual and Mechanical Inspection
1. Verify that contractor has cleaned enclosure interiors of accumulated dust, dirt, oil films, and other foreign material.
2. Inspect all electrical and mechanical components for condition and any evidence of defects or failure.
3. Check output circuit breaker(s) bus connection.
4. Inspect bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections.
5. Inspect for missing or loose hardware or accessories.
6. Inspect grounding system connections.
7. Operate key and door interlock devices to assure proper operation.
8. Inspect all associated systems and circuits for proper operation, including but not limited to the fuel supply system, jacket heater, battery charger, engine mounted control panel, remote monitoring and control panel, emergency cut-off, battery lighting system, exhaust system, radiator system, and ventilator system.
9. Inspect anchoring and vibration isolation systems.

B. Electrical Tests.
1. Insulation resistance test: Megger main poles of output circuit breaker(s) pole-to-pole, from each pole to ground, and across the open contacts of each pole.
2. Contact Resistance Test: Ductor across main pole contacts of output circuit breaker(s) with breaker closed and latched to check for good, low resistance contact.
3. Follow completely the load testing procedures of the latest issue of NFPA-110 for EPS systems, including prior notification of the local inspection authority having jurisdiction. Include all measured data and conditions in the final report. All non-compliance items shall be corrected by the contractor and retested until full compliance with NFPA-110 is achieved.

3.7 GROUNDING SYSTEM

A. Visual and Mechanical Inspection
1. Inspect wiring system outlet and junction boxes for proper grounding. Green grounding conductor shall be connected to outlet and junction boxes. Inspect a minimum of 5% of project boxes.
2. Verify connections of grounds for the secondary of separately derived grounding systems, i.e. at dry type transformers. Note type of connection, i.e. mechanical or exothermic.
3. Verify proper connection to all components of building service entrance grounding system. Note all system components which are interconnected and type of connection either mechanical or exothermic. Note depth of driven ground rods.

B. Electrical Tests (Small Systems)
1. Perform ground-impedance measurements utilizing the fall-of-potential method per ANSI/IEEE Standard 81 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System". Instrumentation utilized shall be specifically designed for ground impedance testing. Provide sufficient spacing so that plotted curves flatten in the 62% area of the distance between the item under test and the current electrode.

C. Equipment Grounds
1. Utilize two-point method of IEEE Std. 81. Measure between equipment ground being tested and known low-impedance grounding electrode or system.

D. Test Values
1. The main ground electrode system impedance-to-ground should be no greater than five (5) ohms for commercial or industrial systems and one (1) ohm of less for generating stations, transmission stations, and large industrial systems. Equipment grounds, depending on size and length of grounding conductor, should be only fractionally higher than system ground.

3.8 CABLES - LOW-VOLTAGE - 600V MAXIMUM

A. Visual and Mechanical Inspection
1. Inspect cables for physical damage and proper connection in accordance with single-line diagram.
2. Test cable mechanical connections to manufacturer's recommended values using a calibrated torque wrench.
3. Check cable color coding with applicable engineer's specifications and National Electrical Code standards.

B. Electrical Tests
1. Perform insulation-resistance test on each feeder on the riser diagram with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for 1 minute.
2. Perform continuity test to insure proper cable connection.

C. Test Values

1. Evaluate results by comparison with cables of same length and type. Investigate any values less than 50 megohms.

3.9 GROUND-FAULT SYSTEMS (NEC 230-95)

A. Visual and Mechanical Inspection
1. Inspect for physical damage and compliance with drawings and specifications.
2. Inspect neutral main bonding connection to assure:
   a. Zero-sequence sensing system is grounded.
   b. Ground-strap sensing systems are grounded through sensing device.
   c. Ground connection is made ahead of neutral disconnect link on zero-sequence sensing systems.
   d. Grounded conductor (neutral) is solidly grounded.
3. Inspect control power transformer to ensure adequate capacity for system.
4. Manually operate monitor panels (if present) for:
   a. Trip test
   b. No trip test
   c. Nonautomatic reset
5. Record proper operation and test sequence.
6. Set pickup and time-delay settings in accordance with the settings provided by the owner/user's electrical engineer.

B. Electrical Tests
1. Measure system neutral insulation to ensure no shunt ground paths exist. Remove neutral-ground disconnect link. Measure neutral insulation resistance and replace link.
2. Determine the relay pickup current by current injection at the sensor and operate the circuit interrupting device.
3. Test the relay timing by injecting three hundred percent (300%) of pickup current, or as specified by manufacturer.
4. Test the system operation at fifty-seven percent (57%) rated control voltage, if applicable.
5. Test zone interlock systems by simultaneous sensor current injection and monitoring zone blocking function.
6. On multiple source, tie breaker, etc., systems, devise a simulation scheme that fully proves correct operation.

C. Test Parameters
1. System neutral insulation shall be a minimum of one hundred (100) ohms, preferably one (1) megohm or greater.
2. Relay timing shall be in accordance with manufacturer's published time-current characteristic curves but in no case longer than one (1) second for fault currents equal to or greater than 3,000 amperes.
3. Relay pickup value shall be within +/- 10% of setting and in no case greater than 1200A.

END OF SECTION