

MoDOT

NW District Office Backup Generator St. Joseph, MISSOURI

JANUARY 2015

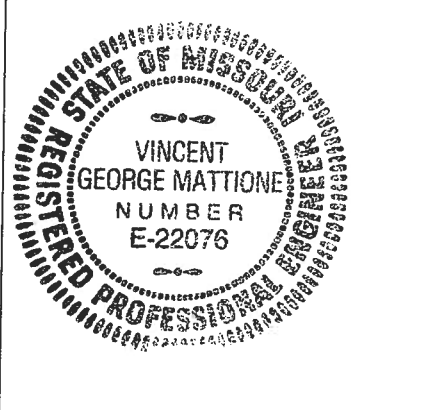
Prepared By:
Shafer, Kline & Warren, Inc.
1700 Swift Ave
Suite 100
North Kansas City, MO 64116
816-756-0444

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	<p>I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Missouri.</p>
	<p>Signature: <u><i>V. G. Mattione</i></u> Date: <u>1/27/2015</u></p>
	<p>Name: <u>Vincent Mattione</u></p>
	<p>Missouri License No.: <u>PE-022076</u></p>
	<p>My license renewal date is <u>12/31/2016</u>.</p>
	<p>Pages, Sheets, or Divisions covered by this seal: <u>Specifications and Drawings</u></p>

SECTION 01010 – SUMMARY OF WORK

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 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Project consists of installing an emergency standby generator and transfer switch at the MoDOT NW District Office, located at:

Project Location: 3602 N. Belt Hwy, St. Joseph, MO 64506

- B. Contract Documents, dated 27 January 2015 were prepared for the Project by **Shafer Kline & Warren, 1700 Swift, North Kansas City, Missouri 64116**.
- C. The Work consists of providing and installing an emergency standby generator, automatic transfer switch, switchboard, equipment pads, natural gas line extension and associated wiring and miscellaneous related items, along with removal of some existing wiring.
- D. The Work will be constructed under a single prime contract.

1.3 CONTRACTOR USE OF PREMISES

- A. Use of the Site: Limit use of the premises to work in areas indicated. Confine operations to areas within contract limits indicated. Do not disturb portions of the site beyond the areas in which the Work is indicated.
 - 1. Owner Occupancy: Allow for Owner occupancy and use by the public.
 - 2. Driveways and Entrances: Keep driveways and entrances serving the premises clear and available to the Owner, the Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- B. Use of the Existing Building: Repair damage cause by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period.

1.4 OCCUPANCY REQUIREMENTS

Full Owner Occupancy: The Owner will occupy the site and existing building during the entire construction period. Cooperate with the Owner during construction operations to minimize conflicts and facilitate owner usage.

PART 2 - EXECUTION**2.1 COORDINATION**

- A. Perform the Work so as not to interfere with the Owner's operations. Coordinate any outages with the utility and with the owner. The owner requires 3 days notice. Outages shall occur during non-business hours (Friday 5pm until Monday at 6am and holidays) so that there is no interruption of business.

2.2 WORK SUMMARY

- A. The below description is a summary of the major project tasks. Refer to project drawings and specifications for additional details.
- Locate existing utilities.
 - Install junction box and conduit as far as possible in General Services building.
 - Excavate and install underground conduit near General Services building. Expose conduit for new underground pull box.
 - Excavate and expose existing conduit and below grade pull box near Main office building.
 - Excavate and install gas line extension to generator area.
 - Stabilize soil and install concrete pads for generator, transfer switch and switchboard panel.
 - Install generator, transfer switch and switchboard on concrete pads.
 - Install conduits and wire between generator, transfer switch and switchboard. Connect gas line to generator. Install 100A lighting panel.
 - Install power and control wiring.
 - Perform final electrical tie-ins.
 - Purge gas line and connect to generator.
 - Restore excavated areas.
 - Commission and test system.

END OF SECTION 01010

SECTION 01040 – COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and supervisory requirements necessary for coordinating construction operations including, but not necessarily limited to, the following:
 - 1. Coordination with MoDOT staff.
 - 2. Coordination with the Construction Representative concerning special requirements in connection with this work.

1.3 COORDINATION

- A. The Contractor shall coordinate construction operations for this project with the Construction Representative and facility personnel to assure efficient and orderly completion of the Work.
 - 1. Schedule construction operations in the sequence required to obtain the best results.
 - 2. Coordinate construction operations to allow existing facility to remain in operation while the Work is being performed.
 - 3. Coordinate construction operations to accommodate construction operations of other contracts let by the Owner.
- B. The Contractor shall, where necessary, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports and attendance at meetings.
 - 1. Prepare similar memoranda for the Owner and separate contractors where coordination of their work is required.
- C. Administrative Procedures: The Contractor shall coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and assure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 - 1. Preparation of schedules.
 - 2. Installation and removal of temporary facilities.
 - 3. Delivery and processing of submittals.
 - 4. Progress meetings.
 - 5. Project closeout activities.

PART 2 - PRODUCTS (Not Applicable)**PART 3 - EXECUTION****3.1 GENERAL COORDINATION PROVISIONS**

- A. A pre-construction conference will be held prior to beginning of construction. The date, time and exact place of this meeting will be determined after contract award and notification of all interested parties. The Contractor shall arrange to have the job superintendent and all prime subcontractors present at the meeting. During the pre-construction conference, the construction procedures and information necessary for submitting payment requests will be discussed and materials distributed, along with any other pertinent information.
- B. Perform the Work so as not to interfere with the Owner's operations. Coordinate any outages with the utility and with the owner. The owner requires 3 days notice. Outages shall occur during non-business hours (Friday 5pm until Monday at 6am and holidays) so that there is no interruption of business.

END OF SECTION 01040

SECTION 01300 – SUBMITTALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for submittals required for performance of the Work, including the following:
 - 1. Shop Drawings.
 - 2. Product Data.
 - 3. Operating and Maintenance Manuals.
 - 4. Warranties.
- B. Administrative Submittals: Refer to General and Supplementary Conditions other applicable Division 1 Sections and other Contract Documents for requirements for administrative submittals. Such submittals include, but are not limited to, the following:
 - 1. Construction Progress Schedule including Schedule of Values.
 - 2. Performance and Payment Bonds.
 - 3. Insurance certificates.
 - 4. Applications for Payment.
 - 5. Certified Payroll Reports.
 - 6. Partial and Final Receipt of Payment and Release Forms.
 - 7. Affidavit Compliance with Prevailing Wage Law.
 - 8. Record Drawings.
 - 9. Notification, Permits, etc.
- C. The Contractor is obliged and responsible to check all shop drawings and schedules to assure compliance with contract plans and specifications. The Contractor is responsible for the content of the shop drawings and coordination with other contract work. Shop drawings and schedules shall indicate, in detail, all parts of an item or work, including erection and setting instructions and integration with the work of other trades.
- D. The Contractor shall at all times make a copy, of all approved submittals, available on site to the Construction Representative.

1.3 SUBMITTAL PROCEDURES

- A. The Contractor shall comply with the General and Supplementary Conditions and other applicable sections of the Contract Documents. The Contractor shall submit, with such promptness as to cause no delay in his work or in that of any other contractors, all required submittals indicated in Part 3.1 of this section and elsewhere in the Contract Documents. Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.
 - a. The Designer reserves the right to withhold action on a submittal requiring coordination with other submittals until all related submittals are received.
- B. Each drawing and/or series of drawings submitted must be accompanied by a letter of transmittal giving a list of the titles and numbers of the drawings. Each series shall be numbered consecutively for ready reference and each drawing shall be marked with the following information:
1. Date of Submission
 2. Name of Project
 3. Location
 4. Section Number of Specification
 5. State Project Number
 6. Name of Submitting Contractor
 7. Name of Subcontractor
 8. Indicate if item is submitted as specified or as a substitution

1.4 PRODUCT DATA

- A. The Contractor shall comply with the General Conditions, Article 3.2.
- B. The Contractor shall collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information, such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves.
1. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products that are not required, mark copies to indicate the applicable information. Include the following information:
 - a. Manufacturer's printed recommendations.
 - b. Compliance with trade association standards.
 - c. Compliance with recognized testing agency standards.
 - d. Application of testing agency labels and seals.
 - e. Notation of dimensions verified by field measurement.
 - f. Notation of coordination requirements.
 2. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.

1.5 OPERATING AND MAINTENANCE MANUALS AND WARRANTIES

- A. The Contractor shall submit all required manufacturer's operating instructions, maintenance/service manuals and warranties in accordance with the General Conditions Article 3.5 and Supplementary Conditions and this and other sections of the Contract Documents.

PART 2 - PRODUCTS (Not Applicable)**PART 3 - EXECUTION****3.1 REQUIRED SUBMITTALS**

- A. Contractor shall submit the following information for materials and equipment to be provided under this contract.

		TYPE OF SUBMITTAL											
SECTION	DESCRIPTION	Shop Drawings	Product Data	Sample	Certifications	Manufacturer's Instructions	Test report	Inspection Report	Wiring Diagrams	Record Photographs	Maintenance Data	Operating Instruction	Warranty
	Generator		x			x	x		x		x	x	x
	Automatic Transfer Switch		x			x			x		x	x	x
	Conduit		x			x					x		
	Conductors		x			x					x		
	Gas Pipe		x			x					x		
	Switchboard		x			x			x				x
	Lighting Panel		x			x			x				x

END OF SECTION 01300

SECTION 01710 – CLEANING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for cleaning during the Project.
- B. Environmental Requirements: Conduct cleaning and waste-disposal operations in compliance with local laws and ordinances. Comply fully with federal and local environmental and anti-pollution regulations.
 - 1. Do not dispose of volatile wastes, such as mineral spirits, oil, or paint thinner, in storm or sanitary drains.
 - 2. Burning or burying of debris, rubbish, or other waste material on the premises is not permitted.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by the manufacturer or fabricator for the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 PROGRESS CLEANING

- A. General
 - 1. Retain all stored items in an orderly arrangement allowing maximum access, not impeding drainage or traffic, and providing the required protection of materials.
 - 2. Do not allow the accumulation of scrap, debris, waste material, and other items not required for construction of this Work.
 - 3. At least **once** each week, and more often if necessary, completely remove all scrap, debris, and waste material from the job site.
 - 4. Provide adequate storage for all items awaiting removal from the job site, observing all requirements for fire protection and protection of the ecology.
- B. Site:
 - 1. Daily, inspect the site and pick up all scrap, debris, and waste material. Remove all such items to the place designated for their storage.

2. Weekly, inspect all arrangements of materials stored on the site. Re-stack, tidy, or otherwise service all material arrangements.
3. Maintain the site in a neat and orderly condition at all times.

3.2 FINAL CLEANING

- A. General: Provide final cleaning operations when indicated. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit of Work to the condition expected from a commercial building cleaning and maintenance program. Comply with manufacturer's instructions.
- B. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for the entire Project or a portion of the Project.
 1. Clean the Project Site, yard and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and foreign substances.
 2. Sweep paved areas broom clean. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 3. Remove petrochemical spills, stains, and other foreign deposits.
 4. Remove tools, construction equipment, machinery, and surplus material from the site.
 5. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 6. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 7. Broom clean concrete floors in unoccupied spaces.
 8. Remove labels that are not permanent labels.
 9. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
 - a. Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
 10. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 11. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs and defective and noisy starters in fluorescent and mercury vapor fixtures.
 12. Leave the Project clean and ready for occupancy.
- C. Compliances: Comply with governing regulations and safety standards for cleaning operations. Remove waste materials from the site and dispose of lawfully.
 1. Where extra materials of value remain after Final Acceptance by the Owner, they become the Owner's property.

END OF SECTION 01710

SECTION 15195 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig (690 kPa) minimum unless otherwise indicated.
2. Service Regulators: 65 psig (450 kPa) minimum unless otherwise indicated.

B. Natural-Gas System Pressure within Buildings: 0.5 psig (3.45 kPa) or less.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.

2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

B. PE Pipe: ASTM D 2513, SDR 11.

1. PE: Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
3. Transition Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
 - b. Outlet shall be threaded or suitable for welded connection.
 - c. Bridging sleeve over mechanical coupling.
 - d. Factory-connected anode.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.

2.2 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.3 MANUAL GAS SHUTOFF VALVES

- A. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.
 1. CWP Rating: 125 psig (862 kPa).
 2. Threaded Ends: Comply with ASME B1.20.1.
 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.

6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.

B. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Lyall, R. W. & Company, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Perfection Corporation; a subsidiary of American Meter Company.
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig (4140 kPa).
9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.4 DIELECTRIC UNIONS

A. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Jomar International Ltd.
 - d. Matco-Norca, Inc.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc. Wilkins; a Zurn company.
2. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 24 inches (600 mm) below finished grade. Comply with requirements in Section 02300 "Earthwork" for excavating, trenching, and backfilling.
- C. Install underground, PE, natural-gas piping according to ASTM D 2774.
- D. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 - 3. Replace pipe having damaged PE coating with new pipe.
- E. Install fittings for changes in direction and branch connections.
- F. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Section 15127 "Meters and Gages for HVAC Piping."

3.2 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

- E. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).

3.4 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.5 LABELING AND IDENTIFYING

- A. Install detectable warning tape directly above gas piping, 12 inches (300mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.6 FIELD QUALITY CONTROL

- A. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.
- B. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.7 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping shall be one of the following:

1. PE pipe fittings joined by heat fusion; service-line risers with tracer wire terminated in an accessible location.
2. Annealed-temper copper tube with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.

B. Aboveground natural-gas piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

3.8 INDOOR PIPING SCHEDULE

A. Aboveground, distribution piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

B. Underground, below building, piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

3.9 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.

3.10 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 (DN 50) and smaller at service meter shall be one of the following:

B. Distribution piping valves for pipe sizes NPS 2 (DN 50) and smaller shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

C. Valves in branch piping for single appliance shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION 15195

SECTION 16000 - ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide complete distribution systems for electrical power as shown on the drawings or required by other sections of these specifications.
- B. Work includes, but is not necessarily limited to:
 - 1. Rework the existing 208V, 3 phase, 4 wire services.
 - 2. Install a service rated transfer switch, switchboard and generator set.
 - 3. Branch circuit wiring in conduit for engine auxiliaries.
 - 4. Hangers, anchors, sleeves, chases, supports for fixtures, and other electrical materials and equipment in association therewith.
 - 5. Grounding System.
 - 6. Removal of old wiring.

1.2 APPLICABLE PUBLICATIONS

- A. Industry publications controlling the work of this Section include:
 - 1. American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE):
 - ANSI/IEEE C57.12.91: Test Code for Dry-Type Distribution and Power Transformers.
 - ANSI/IEEE C57.110-1986: Recommended Practice for Establishing Transformer Capability When Supplying Nonsinusoidal Load Currents.
 - ANSI/IEEE C62.41-1980: Guide for Surge Voltages in Low Voltage AC Power Circuits.
 - 2. American Society for Testing and Materials (ASTM):
 - ASTM B8: Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
 - 3. National Electrical Manufacturer's Association (NEMA):
 - NEMA FU 1: Low Voltage Cartridge Fuses.
 - NEMA ICS: Motor Starters.
 - NEMA PB 1: Panelboards.
 - NEMA ST20: Dry-Type Transformers for General Applications.
 - NEMA WD 1: Wiring Devices.
 - MG 1: Motors And Generators

4. National Fire Protection Association (NFPA):
 - NFPA 70: National Electrical Code (NEC).
 - NFPA 78: Lightning Protection Code.
 - NFPA 101: Life Safety Code.
 - NFPA 110: Emergency and Standby Power Systems.
 - NFPA 110A: Stored Electrical Energy Emergency and Standby Power Systems.
5. Occupational Safety and Health Administration (OSHA):
Occupational Safety and Health Standards.
6. Underwriters Laboratories Inc. (UL):
 - UL 20: General Use Snap Switches.
 - UL 57: Electric Lighting Fixtures.
 - UL 67: Panelboards.
 - UL 96: Lightning Protection Components.
 - UL 96A: Installation Requirements for Lightning Protection Systems.
 - UL 98: Enclosed and Dead-Front Switches.
 - UL 198E: Class R Fuses.
 - UL 498: Attachment Plugs and Receptacles.
 - UL 542: Lampholders, Starters and Starter Holders for Fluorescent Lamps.
 - UL 935: Fluorescent Lamp Ballasts.
 - UL 943: Ground-Fault Circuit Interrupters.

1.3 SUBMITTALS.

- A. Submit the following in accordance with Division 1. Submittals are for the record or approval, as indicated.
 1. Catalog cuts of grounding conductor, ground rods and connectors for the record.
 2. Catalog cuts of panelboards, receptacles and switches for the record.
 3. Catalog cuts of power and control cable and connectors for the record.
 4. Drawing showing layout and components for the exterior lighting control panel including physical dimensions, schematic diagram and wiring diagram, for approval.
- B. Upon completion of this portion of the work, and as a condition of its acceptance, submit the following:
 1. As-built drawings.
 2. Copies of all circuit directories.
 3. Copies of all warranties and guarantees.
 4. Emergency instructions.
 5. Spare parts list.
 6. Wiring diagrams.
 7. Inspection procedures.
 8. Shop drawings and product data.

9. Operations and Maintenance manuals including the following information for equipment items:
 - a. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 - b. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions.
 - c. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

1.4 COORDINATION.

- A. Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.
- B. Coordinate with the local electric utility to ensure that the service entrance is installed according to all requirements of the utility.
- C. Perform the Work so as not to interfere with the Owner's operations. Coordinate any outages with the utility and with the owner. The owner requires 3 days notice. Outages shall occur during non-business hours (Friday 5pm until Monday at 6am and holidays) so that there is no interruption of business.

1.1 TRAINING.

- A. Upon completion of work, at a time directed, a knowledgeable representative of the Contractor shall be made available for a period of not less than 4 hours to instruct a representative(s) of the Owner in the operation and maintenance of the electrical systems and components.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Provide only materials that are new, of the type and quality specified, and free from defects and imperfections. Where Underwriters Laboratories Inc. has established standards for such materials, provide only materials bearing the UL label.
- B. Manufacturers that can provide products meeting these specifications have been identified. Other manufacturers' products meeting these specifications may be acceptable subject to submittal of certificate of compliance, review, and approval. Where catalog numbers are shown, they should be verified with the manufacturer to assure continued accuracy and compliance with these specifications.
- C. All materials and equipment of the same type shall be made by the same manufacturer.
- D. All materials and equipment shall be acceptable to the authority having jurisdiction as

suitable for the use intended.

2.2 DISTRIBUTION

A. Conduit, Fittings:

1. Rigid Galvanized Steel Conduit (RGS):
 - a. Each length threaded on both ends.
 - b. All scale, grease, dirt, burrs, and other foreign matter removed from inside and outside prior to application of coating materials.
 - c. Galvanized by the hot-dip process as follows:
 - 1) Interior and exterior surfaces coated with a solid, unbroken layer of 99% virgin zinc by dipping.
 - 2) One coat of zinc chromate finish on inside and outside surfaces to prevent oxidation and white rust.
 - d. Couplings and elbows fabricated, coated, and finished by the same process as conduit.
 - e. Where conduits enter boxes or cabinets without threaded hubs, double locknuts shall be used plus a phenolic insulated metallic bushing on the open end.
2. Rigid Polyvinyl Chloride (PVC) Conduit:
 - a. Fabricated from self-extinguishing, high-impact, polyvinyl chloride designed for above ground and underground installations.
 - b. Type EPC, Schedule 40, heavy-wall rigid conduit, unless noted otherwise.
 - c. Fittings and accessories fabricated from same material as conduit.
 - d. Solvent-cement-type joints as recommended by manufacturer.
3. Flexible Liquid-tight Metal Conduit:
 - a. UL listed.
 - b. Standard weight (36 lbs/100' minimum).
 - c. Plastic coated galvanized zinc-coated steel.
 - d. Fittings shall be designed for use with steel conduit.
4. Conduit clamps, straps and supports shall be steel or malleable iron.

B. Wire and Cable:

1. Sizes indicated on the drawings.
2. Service-entrance cable shall have type THWN or RHW insulation.
3. Feeders and Branch Circuits:
 - a. Flame-retardant, moisture- and heat-resistant thermoplastic with single conductor copper cable, Type THHN/THWN, 600V.
 - b. Rated 75°C maximum conductor temperature in wet locations and 90°C in dry locations.
 - c. Conductor composed of 98% IACS, (International Annealed Copper Standards) soft annealed copper conforming to ASTM B8.
 - d. Conductor insulated with polyvinyl chloride to conform to or exceed Insulated Cable Engineers Association (ICEA) Standards.

C. Boxes:

1. Outlets, Junction Boxes, and Switch Boxes:

- a. Provide standard one-piece, galvanized steel units of shape and size best suited to that particular location, of sufficient size to contain enclosed wires without crowding.
- b. Provide deep boxes for 1" and larger conduit.
- c. For lighting outlets, provide standard 4" octagon or square units, with 3/8" malleable iron fixture studs and box hangers where required.
- d. For flush mounted switches and receptacles, provide deep gang boxes. For exposed work, provide cast steel boxes with galvanized or cadmium-plated steel covers. Provide boxes 4" x 4" square by 1-1/2" deep, except for boxes at the end of a run containing a single device.
- e. For pull boxes, provide galvanized code-gauge sheet steel units with screwed-on covers, of size and shape required to accommodate wires without crowding, and to suit the location.

D. Connections to Equipment:

1. Power Cable Connectors:
 - a. For all wire, cable, equipment and bus terminals, designed and sized for the specific cable or bus being connected.
 - b. Solder-less, pressure-type connectors constructed of high-strength, non-corrodible, tin-plated copper designed to furnish high-pullout strength and high-conductivity joints.
 - c. Rated current-carrying capacity equal to, or greater than, the cable being connected and with silver-plated contact surfaces for conductors of 500-kcmil copper capacity or greater.

E. Supporting Devices:

1. Conduit or equipment supports shall be galvanized steel support channel adequate for the weight of equipment or conduit, including wiring, which they carry.
2. Fastening hardware shall be corrosion resistant.

F. Identification:

1. Identify all cabinets, transfer switches, and other apparatus used for operation and control of circuits, appliances, and equipment. Provide plastic laminate nameplates, white face with black core letters, showing proper identification. Minimum size nameplate shall be 1" x 3" with 1/4" letters. Labels shall be secured using silicone glue.
2. Wire and cable markers shall be type written vinyl self-laminating markers, which have a clear overlay of vinyl and an aggressive adhesive for adhesion to the wire.
 - a. Identify both ends of wire with the same unique wire number.
 - b. Assign wire numbers where specific designations are not indicated

2.3 POWER SYSTEM

A. Grounding:

1. Ground all power distribution equipment, panelboards, lighting, branch circuit loads, etc. by conductor to the grounding system. All metallic parts of electrical equipment which do not carry current shall be grounded with an equipment grounding conductor whether or not shown on the drawings. The equipment

grounding conductor shall be a green insulated copper conductor. Sizes of grounding conductors shall be in accordance with the NEC unless shown otherwise on drawings. The NEC shall govern and shall not be violated.

2. Provide the following wire for direct buried grounds:
 - a. Bare, uncoated copper cable, unless otherwise noted.
 - b. Conductors composed of 98% IACS soft or annealed copper to conform to the following requirements:
 - 1) Sized per drawings, unless otherwise noted.
 - 2) Solid conductors in sizes No. 4 AWG and smaller.
 - c. Sources: Anaconda; General Cable; General Electric; Triangle or engineer approved equal
3. Ground Rods:
 - a. Copper-clad steel or copper alloy, sectional type rods.
 - b. One end pointed to facilitate driving.
 - c. 3/4" diameter and 10'-0" long with diameter and length stamped near top of rod.
4. Connection Materials:
 - a. Cable-to-cable, cable-to-rod, cable-to-connector, and cable-to-building steel connections of exothermic welding process, unless otherwise noted.
 - b. Cable-to-equipment ground lugs:
 - 1) Bolted to equipment housing with silicon bronze bolts and lock washers.
 - 2) All equipment grounding shall be free of paint or any other material covering bare metal.
 - c. Sources: Cadweld; OZ/Gedney; Weaver; Engineer approved equal.

PART 3 - EXECUTION

3.1 LABOR AND WORKMANSHIP.

- A. All labor for the installation of materials and equipment furnished for the electrical system shall be done by experienced mechanics of the proper trades.
 1. All electrical equipment furnished shall be adjusted, aligned and tested by the Contractor as required to produce the intended performance.
 2. Upon completion of the work, thoroughly clean all exposed portions of the electrical installation, removing all traces of soil, labels, grease, oil, and other foreign material, and using only the type of cleaner recommended by the manufacturer for the item being cleaned.

3.2 COORDINATION.

- A. Coordinate as necessary with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.
 1. Coordinate the installation of electrical items with the schedule for work of other trades to prevent unnecessary delays in the total work.

2. Installation of exposed conduit or other equipment shall not occur until all piping, pipe hangers, ducts and equipment which are above have been installed, and provided on site by others.
3. Where lighting fixtures and other electrical items are shown in conflict with locations of structural members, mechanical items, or other equipment, provide required supports and wiring to clear the encroachment.
4. Data indicated on the drawings and in these specifications are as exact as could be secured, but their absolute accuracy is not warranted. The exact locations, distances, levels, and other conditions will be governed by actual construction and the drawings and specifications should be used only for guidance in such regard.
5. Verify all measurements at the building. No extra compensation will be allowed because of dimensional differences between the drawings and actual measurements at the site of construction.
6. The electrical drawings are diagrammatic, but shall be followed as closely as actual construction and work of other trades will permit. Where deviations are required to conform with actual construction and the work of other trades, make such deviations without additional cost to the Owner.
7. Perform trenching, bedding, and backfilling associated with the work of this Section in strict accordance with the provisions of Section 02210, EARTHWORK, of these specifications.

3.3 INSTALLATION.

A. Conduits:

1. Install using as few joints as possible.
2. Provide RGS conduit for all conduit penetrating interior concrete walls and floors and for all exposed, exterior conduit.
3. Provide Schedule 40 PVC or RGS conduit below grade, unless noted otherwise. Minimum burial depth outside of building shall be 24" clear to top of conduit, unless noted otherwise.
4. Use galvanized flexible steel conduit for interior system only, except as prohibited by NEC and subject to approval by engineer.
5. Use galvanized flexible steel conduit between rigid conduit and terminal boxes where direct connection is not desirable for reasons of equipment movement, vibration, or for ease of maintenance.
6. Install galvanized flexible steel conduit at all points of connection to equipment mounted on supports to allow for expansion and contraction.
7. All conduits above floor slab and within the building shall run parallel to, or at right angles with, lines of the building.
8. Securely fasten and rigidly support conduits from the main structure of the building. Raceways shall be securely supported and fastened in place at intervals of not more than 10'-0" with pipe straps, wall brackets, hangers, or ceiling trapeze. Do not support conduit from other conduits, HVAC ducts, or equipment.
9. Where conduits pass through stem walls or above grade exterior walls of the building, use link seal system.
10. The number of raceways shall be installed per drawings. Circuits shall not be combined to reduce number of raceways.

11. Provide and install junction boxes ahead of panelboard where three or more items of equipment are supplied from the same circuit breaker. Make splices in the junction box.
12. Where conduit has to be cut in the field, it shall be cut square with a pipe cutter using cutting knives.
13. All conduits shall be swabbed clean by pulling an appropriate size mandrel through the conduit before installation of wire or cable. Clear all blockages and remove burrs, dirt, and debris.
14. Where conduit size is not indicated, install minimum 3/4" conduit.
15. Plugs shall be installed in all unused openings of all fittings, boxes, and panel boards.
16. Contractor is responsible for protecting all conduits during construction. Temporary openings in the conduit system shall be plugged or capped to prevent entrance of moisture or foreign matter. Contractor shall replace any conduits and/or ducts containing foreign materials that cannot be removed.
17. All conduits leaving the building shall slope away from the building.

B. Conductors:

1. Unless otherwise shown on the drawings, use No. 12 AWG conductors for all branch circuits, protected by 20A circuit breakers.
2. The number of wires in a conduit run is indicated on the cable and conduit schedule.
 - a. Where wire size is not shown, install No. 12 AWG conductors for power circuits and No. 14 AWG for control circuits.
 - b. Provide code-sized conduit and boxes for number and size of wires shown or required, unless a larger size is shown on the drawings.
3. All wire shall be color coded as follows:

<u>Description</u>	<u>208/120 Volt</u>
Phase A	Black
Phase B	Red
Phase C	Blue
Neutral	White
Ground	Green

4. Splices shall be made only at outlets, junction boxes, or accessible raceways.
 - a. Make splices electrically and mechanically secure with pressure-type connectors.
 - b. Insulate splices with a minimum of two half-lapped layers of UL listed, 90°C rated, vinyl-plastic electrical tape where insulation is required.
5. The drawings indicate the general direction of home runs. Continue all such home runs to the panel as though the routes were shown completely. Circuits for more than one home run shall not be combined in a common pull box.
6. Each conductor installed in pull boxes, outlet and junction boxes and at load connections shall be identified with branch circuit or feeder number for power and lighting; and with control wire number as indicated on equipment manufacturer's shop drawing for control circuits.
7. Single conductor and multi-conductor cable shall not be bent to radii smaller than that specified by the manufacturer or by the National Electrical Code. Special pull boxes or oversized conduits shall be used to meet this requirement.
8. Pulling lubricants shall be soapstone powder, powdered talc, or a commercial pulling compound. No soap suds, soap flakes, oil, or grease shall be used, as these

may be harmful to cable insulation. Contractor shall use nylon or hemp rope for pulling cable to avoid scoring the conduit.

9. Cables shall be neatly trained, without interlacing, and be of sufficient length in all boxes, equipment panels, etc. to permit making a neat arrangement. Jackets of multi-conductor control cables shall be removed as required to properly train and terminate the conductors. Cables shall be secured in a manner to avoid tension on conductors or terminals, and shall be protected from mechanical injury and from moisture at the unprotected end. Sharp bends over conduit bushings are prohibited. Damaged cables shall be removed and replaced at the Contractor's expense.

C. Wiring Devices:

1. Install wiring devices as indicated, in compliance with manufacturer's written instructions, applicable requirements of the NEC and NEMA standards and in accordance with recognized industry practices.
2. Coordinate with other work, including painting, electrical box and wiring work as necessary to interface installation of wiring devices.
3. Install wiring devices only in electrical boxes which are clean, free from excess building materials, dirt and debris. All device boxes concealed in walls shall be installed flush with the surface of the finished wall.

D. Grounding:

1. Install grounding system as shown on the drawings.
2. Install ground rods as indicated on the drawings, by driving and not by drilling or jetting.
3. Drive ground rods into unexcavated portion of the earth where possible.
4. Where ground rods must be installed in excavated areas, drive rods into earth after compaction of backfill is completed.
5. Drive to a depth such that the top of ground rods will be approximately 12" below finish grade, or subgrade, and connect to counterpoise.
6. Rotate each ground rod 180° for every foot it is driven to prevent undetected deflection. If it cannot be rotated, a new ground rod shall be driven.
7. Conform to manufacturer's instructions for grounding system connections. All ground connections shall be inspected for tightness. Exothermic-welded connections shall be approved before being permanently concealed.
8. Chemically degrease and dry connections completely before welding.
9. Apply one coat of asphaltic coating to all exothermic-welded connections to be buried.
10. Make connections to equipment as follows:
 - a. Make up clean and tight to assure a low-resistance connection with resistance drop not exceeding 1 ohm.
 - b. Install so as not to be susceptible to mechanical damage during operation or maintenance of equipment.
 - c. Provide direct copper connection to counterpoise.
11. A separate, continuous, insulated equipment grounding conductor shall be installed in all feeder and branch circuits. Splicing on receptacle ground terminals shall not be allowed.
12. A separate neutral conductor shall be installed for each branch circuit. Combining neutrals shall not be allowed.
13. Bond all insulated grounding bushings with a bare #6 AWG grounding conductor to a ground plate or ground bus.
14. Direct buried ground conductors shall be installed at a nominal depth of **30"** below

- grade, unless noted otherwise.
15. All grounding conductors embedded in or penetrating concrete shall be insulated.

3.4 ACCEPTANCE TESTING.

A. General:

1. Provide personnel and equipment, make required tests, and submit test reports upon completion of tests.
2. Provide temporary power source of proper type for testing purpose when normal supply is not available.
3. Make written notice to the Owner adequately in advance of each of the following stages of construction:
 - a. In the underground condition prior to placing concrete floor slab, when all associated electrical work is in place.
 - b. When all rough-in is complete, but not covered.
 - c. After all exothermic-welded connections are made, but not concealed.
 - d. At completion of the work of this section.
4. When material and/or workmanship is found not to comply with the specified requirements, the noncomplying items shall be removed from the jobsite and replaced with items complying with the specified requirements promptly after receipt of notice of such non-compliance.

B. Test Procedures:

1. All feeders shall have their insulation tested after installation, but before connection to devices. The conductors shall test free from short circuits and grounds.
2. Prior to energizing circuitry, test wiring devices for electrical continuity and proper polarity connections.
3. After installation is complete, the equipment shall be demonstrated to operate satisfactorily and to conform to contract documents.
4. Measure and record voltages between phases and between phase wires and neutrals. Submit a report of maximum and minimum voltages.
5. Perform ground test to measure ground resistance of counterpoise. Resistance shall be 5 ohms or less.

C. System Functional Test:

1. Upon completion of equipment tests, a system functional test shall be performed. It is the intent of this test to prove the proper interaction of the power and control systems.

END OF SECTION

SECTION 16231 - PACKAGED ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes packaged engine-generator sets for standby power supply with the following features:
 - 1. Natural Gas engine.
 - 2. Unit-mounted cooling system.
 - 3. Unit-mounted control and monitoring.
 - 4. Outdoor enclosure.
- B. See Division 16 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.2 DEFINITIONS

- A. Emergency Standby Power (ESP): Per ISO 8528: The maximum power available during a variable electrical power sequence, under the stated operating conditions, for which a generating set is capable of delivering in the event of a utility power outage or under test conditions for up to 200 hours of operation per year with the maintenance intervals and procedures being carried out as prescribed by the manufacturers. The permissible average power output (Ppp) over 24 hours of operation shall not exceed 70 percent of the ESP unless otherwise agreed by the RIC engine manufacturer.
- B. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.3 SUBMITTALS

- A. Product Data: For each type of packaged engine generator and accessory indicated. . In addition, include the following:
 - 1. Thermal damage curve for generator.
 - 2. Time-current characteristic curves for generator protective device.
 - 3. Sound test data, based on a free field requirement.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, and location and size of each field connection.
 - 1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
 - 2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

3. Wiring Diagrams: Control interconnection, Customer connections.

C. Certifications:

1. Submit statement of compliance which states the proposed product(s) is certified to the emissions standards required by the location for EPA, stationary emergency application.

D. Source quality-control test reports.

1. Certified summary of prototype-unit test report. See requirements in Part 2 "Source Quality Control" Article Part A. Include statement indicating torsional compatibility of components.
2. Certified Test Report: Provide certified test report documenting factory test per the requirements of this specification, as well as certified factory test of generator set sensors per NFPA110 level 1.
3. List of factory tests to be performed on units to be shipped for this Project.
4. Report of exhaust emissions and compliance statement certifying compliance with applicable regulations.

E. Operation and maintenance data.

F. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

D. Comply with NFPA 37 (Standard For the Installation and Use of Stationary Combustion Engines and Gas Turbines).

E. Comply with NFPA 70 (National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702).

F. Comply with NFPA 110 (Emergency and Standby Power Systems) requirements for Level 1 emergency power supply system.

G. Comply with UL 2200.

1.5 PROJECT CONDITIONS

- A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
1. Ambient Temperature: Minus 18 to plus 40 deg C.
 2. Relative Humidity: 0 to 95 percent.
 3. Altitude: Sea level to 1000 feet

1.6 WARRANTY

- A. Extended Warranty: Manufacturer shall provide an extended coverage of 5 years from date of registered commissioning and start-up. This coverage shall be comprehensive with no deductibles.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: The basis for this specification is Cummins Power Generation equipment, approved equals may be considered if equipment performance is shown to meet the requirements herein.

Note: The same manufacturer shall be used for both the engine-generator and transfer switch.

2.2 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
1. Rigging Information: Indicate location of each lifting attachment, generator-set center of gravity, and total package weight in submittal drawings.
- C. Capacities and Characteristics:
1. Power Output Ratings: Electrical output power rating for Standby operation of not less than 100.0kW, at 80 percent lagging power factor, 120/208, Parallel Wye, Three phase, 4-wire, 60 hertz.
 2. Alternator shall be capable of accepting maximum 497.0 kVA in a single step and be capable of recovering to a minimum of 90% of rated no load voltage. Following the application of the specified kVA load at near zero power factor applied to the generator set.
 3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component. The engine-generator nameplate shall include information of the power output rating of the equipment.

D. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 1.0 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 5 seconds. On application of a 100% load step the generator set shall recover to stable voltage within 10 seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Not more than 15 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 5 seconds. On application of a 100% load step the generator set shall recover to stable frequency within 10 seconds.
6. Output Waveform: At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.
7. Sustained Short-Circuit Current: (For engine-generator sets using a PMG-excited alternator) For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 8 seconds without damage to generator system components. For a 1-phase, bolted short circuit at system output terminals, system shall regulate both voltage and current to prevent over-voltage conditions on the non-faulted phases.
8. Start Time: Comply with NFPA 110, Level 1, Type 10, system requirements.
9. Ambient Condition Performance: Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.
10. Noise Output: Engine generator shall be tested by the manufacturer per ANSI S12.34. Data documenting performance shall be provided with submittal documentation.

E.

2.3 ENGINE

- A. Fuel: Natural Gas
- B. Rated Engine Speed: 1800RPM.
- C. Lubrication System: The following items are mounted on engine or skid:
 1. Lube oil pump: shall be positive displacement, mechanical, full pressure pump.
 2. Filter and Strainer: Provided by the engine manufacturer of record to provide adequate filtration for the prime mover to be used.
 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

- D. Engine Fuel System: The engine fuel system shall be installed in strict compliance to the engine manufacturer's instructions
- E. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity and performance.
 - 1. Designed for operation on a single 120 VAC, Single phase, 60Hz power connection. Heater voltage shall be shown on the project drawings.
 - 2. Installed with isolation valves to isolate the heater for replacement of the element without draining the engine cooling system or significant coolant loss.
 - 3. Provided with a 12VDC thermostat, installed at the engine thermostat housing
- F. Governor: Adjustable isochronous, with speed sensing. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.
- G. Cooling System: Closed loop, liquid cooled
 - 1. The generator set manufacturer shall provide prototype test data for the specific hardware proposed demonstrating that the machine will operate at rated standby load in an outdoor ambient condition of 50 deg C.
 - 2. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 - 3. Size of Radiator overflow tank: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 - 4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 - 5. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 - 6. Duct Flange: Generator sets installed indoors shall be provided with a flexible radiator duct adapter flange.
- H. Muffler/Silencer: Selected with performance as required to meet sound requirements of the application, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements. For generator sets with outdoor enclosures the silencer shall be inside the enclosure.
- I. Air-Intake Filter: Engine-mounted air cleaner with replaceable dry-filter element and restriction indicator.
- J. Starting System: 12 or 24V, as recommended by the engine manufacturer; electric, with negative ground.
 - 1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
 - 2. Cranking Cycle: As required by NFPA 110 for level 1 systems.
 - 3. Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.
 - 4. Battery Compartment: Factory fabricated of metal with acid-resistant finish.

5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation. The battery charging alternator shall have sufficient capacity to recharge the batteries with all parasitic loads connected within 4 hours after a normal engine starting sequence.
6. Battery Chargers: Unit shall comply with UL 1236, provide fully regulated, constant voltage, current limited, battery charger for each battery bank. It will include the following features:
 - a. Operation: Equalizing-charging rate based on generator set manufacturer's recommendations shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 20 deg C to plus 40 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - d. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
 - e. Provide LED indication of general charger condition, including charging, faults, and modes. Provide a LCD display to indicate charge rate and battery voltage. Charger shall provide relay contacts for fault conditions as required by NFPA110.
 - f. Enclosure and Mounting: NEMA, Type 1, wall-mounted cabinet.

2.4 CONTROL AND MONITORING

- A. Engine generator control shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit.
- B. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. (Switches with different configurations but equal functions are acceptable.) When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.
- C. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.

- D. Configuration: Operating and safety indications, protective devices, system controls, engine gages and associated equipment shall be grouped in a common control and monitoring panel. Mounting method shall isolate the control panel from generator-set vibration. AC output power circuit breakers and other output power equipment shall not be mounted in the control enclosure.
- E. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
1. AC voltmeter (3-phase, line to line and line to neutral values).
 2. AC ammeter (3-phases).
 3. AC frequency meter.
 4. AC kVA output (total and for each phase). Display shall indicate power flow direction.
 5. Ammeter-voltmeter displays shall simultaneously display conditions for all three phases.
 6. Emergency Stop Switch: Switch shall be a red “mushroom head” pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating.
 7. Fault Reset Switch: Supply a dedicated control switch to reset/clear fault conditions.
 8. DC voltmeter (alternator battery charging).
 9. Engine-coolant temperature gage.
 10. Engine lubricating-oil pressure gage.
 11. Running-time meter.
 12. Generator-voltage and frequency digital raise/lower switches. Rheostats for these functions are not acceptable. The control shall adjustment of these parameters in a range of plus or minus 5% of the voltage and frequency operating set point (not nominal voltage and frequency values.)
 13. AC Protective Equipment: The control system shall include over/under voltage, over current, short circuit, loss of voltage reference, and over excitation shut down protection. There shall be an overload warning, and overcurrent warning alarm.
 14. Status LED indicating lamps to indicate remote start signal present at the control, existing alarm condition, not in auto, and generator set running.
 15. A graphical display panel with appropriate navigation devices shall be provided to view all information noted above, as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall also include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.
 16. Panel lighting system to allow viewing and operation of the control when the generator room or enclosure is not lighted.
 17. DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control, and annunciate low or high voltage conditions. It shall also provide an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking).
- F. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
1. Overcrank shutdown.
 2. Coolant low-temperature alarm.
 3. Control switch not in auto position.
 4. Battery-charger malfunction alarm.
 5. Battery low-voltage alarm.

- G. Remote Alarm Annunciator: Comply with NFPA 110. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition.

2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Molded-case, static trip, LSI; 100 percent rated; complying with NEMA AB 1 and UL 489.
 - 1. Tripping Characteristic: Designed specifically for generator protection.
 - 2. Trip Rating: Matched to generator rating.
 - 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
 - 4. Mounting: Adjacent to or integrated with control and monitoring panel.

2.6 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H
- D. Temperature Rise: 105 / Class F environment.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over speed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Permanent Magnet Generator (PMG) shall provide excitation power for optimum motor starting and short circuit performance.
- G. Enclosure: Drip-proof.
- H. Voltage Regulator: SCR type, Separate from exciter, providing performance as specified. The voltage regulation system shall be microprocessor-controlled, full wave rectified, and provide a pulse-width modulated signal to the exciter. No exceptions or deviations to these requirements will be permitted.
- I. The alternator shall be provided with anti-condensation heater(s) in all applications where the generator set is provided in an outdoor enclosure, or when the generator set is installed in a coastal or tropical environment.
- J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- K. Subtransient Reactance: 15 percent maximum, based on the rating of the engine generator set.

2.7 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Sound Attenuated Steel housing. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Instruments, control, and battery system shall be mounted within enclosure.
- B. Construction:
 - 1. Hinged Doors: With padlocking provisions. Restraint/Hold back hardware to prevent door to keep door open at 180 degrees during maintenance. Rain lips over all doors.
 - 2. Exhaust System:
 - a. Muffler Location: Within enclosure.
 - 3. Hardware: All hardware and hinges shall be stainless steel.
 - 4. Mounting Base: Suitable for mounting on sub-base fuel tank or housekeeping pad.
 - 5. A weather protective enclosure shall be provided which allows the generator set to operate at full rated load with a static pressure drop equal to or less than 0.5 inches of water.
- C. Engine Cooling Airflow through Enclosure: Housing shall provide ample airflow for engine generator operation at rated load in an ambient temperature of 50 deg C.
- D. Sound Performance: Reduce the sound level of the engine generator while operating at full rated load to a maximum of 80 dBA measured at any location 7 m from the engine generator in a free field environment.
- E. Site Provisions:
 - 1. Lifting: Complete assembly of engine generator, enclosure shall be designed to be lifted into place as a single unit, using spreader bars.
- F. Convenience Outlets: Contractor provided and installed, **GFCI**. Arrange for external electrical connection.

2.8 VIBRATION ISOLATION DEVICES

- A. Vibration Isolation: Generators installed on grade shall be provided with elastomeric isolator pads integral to the generator, unless the engine manufacturer requires use of spring isolation.

2.9 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Powder-coated and baked over corrosion-resistant pretreatment and compatible primer. Manufacturer's standard color or as directed on the drawings.

2.10 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - 1. Tests: Comply with NFPA 110, Level 1 Energy Converters. In addition, the equipment engine, skid, cooling system, and alternator shall have been subjected to actual prototype

tests to validate the capability of the design under the abnormal conditions noted in NFPA110. Calculations and testing on similar equipment which are allowed under NFPA110 are not sufficient to meet this requirement.

- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 - 1. Test engine generator set manufactured for this Project to demonstrate compatibility and functionality.
 - 2. Full load run.
 - 3. Maximum power.
 - 4. Voltage regulation.
 - 5. Steady-state governing.
 - 6. Single-step load pickup.
 - 7. Simulated safety shutdowns.
 - 8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation, application, and alignment instructions and with NFPA 110.
- B. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
- C. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
- D. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.
- E. Equipment shall be initially started and operated by representatives of the manufacturer. All protective settings shall be adjusted as instructed by the consulting engineer.
- F. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

- G. On completion of the installation by the electrical contractor, the generator set supplier shall conduct a site evaluation to verify that the equipment is installed per manufacturer's recommended practice.
- H. Connect fuel piping to engines with a gate valve and union and flexible connector.
 - 1. Natural- and LP-gas piping, valves, and specialties for gas distribution outside the building are specified in Division 2 Section "Natural Gas Distribution."
- I. Ground equipment according to Division 16 Section "Grounding and Bonding."
- J. Connect wiring according to Division 16 Section "Conductors and Cables."
- K. Identify system components according to Division 15 Section "Mechanical Identification" and Division 16 Section "Electrical Identification."

3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection (except those indicated to be optional) for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
 - 3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
 - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - d. Verify that measurements are within manufacturer's specifications.
 - 4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 - 5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
 - 6. Exhaust Emissions Test: Comply with applicable government test criteria.

7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
 8. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
 9. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.
- C. Coordinate tests with tests for transfer switches and run them concurrently.
- D. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- E. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- F. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- G. Remove and replace malfunctioning units and re-inspect as specified above.
- H. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- I. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 1 Section "Demonstration and Training."

3.4 SERVICE AND SUPPORT

- A. The generator set supplier shall maintain service parts inventory for the entire power system at a central location which is accessible to the service location 24 hours per day, 365 days per year. The inventory shall have a commercial value of \$3 million or more. The manufacturer of the generator set shall maintain a central parts inventory to support the supplier, covering all the major components of the power system, including engines, alternators, control systems, paralleling electronics, and power transfer equipment.
- B. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical power system replacement parts in the local service location. Service vehicles shall be stocked with

critical replacement parts. The service organization shall be on call 24 hours per day, 365 days per year. The service organization shall be physically located within 200 miles of the site.

- C. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

END OF SECTION 16231

SECTION 16415 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes automatic transfer switches rated 600 V and less.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
 - 1. Technical data on all major components of all transfer switches and other products described in this section. Data is required for the transfer switch mechanism, control system, cabinet, and protective devices specifically listed for use with each transfer switch. Include steady state and fault current ratings, weights, operating characteristics, and furnished specialties and accessories.
 - 2. Single Line Diagram: Show connections between transfer switch, power sources and load.
- B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
 - 1. Dimensioned outline drawings of assembly, including elevations, sections, and details including minimal clearances, conductor entry provisions, gutter space, installed features and devices and material lists for each switch specified.
 - 2. Internal electrical wiring and control drawings.
 - 3. Interconnection wiring diagrams, showing recommended conduit runs and point-to-point terminal connections to generator set.
 - 4. Installation and mounting instructions, including information for proper installation of equipment to meet seismic requirements.
- C. Manufacturer and Supplier Qualification Data
 - 1. The transfer switch 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.
 - 2. The manufacturer of this equipment shall have produced similar equipment for a minimum period of 10 years. When requested, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Features and operating sequences, both automatic and manual.
 - 2. List of all factory settings of relays, timers and protective devices; provide setting and calibration instructions where applicable.

- E. Warranty documents demonstrating compliance with the project's contract requirements.

1.3 QUALITY ASSURANCE

- A. **Manufacturer Qualifications:** The equipment supplier shall maintain a service center capable of providing training, parts, maintenance and emergency repairs to equipment, including transfer switch generator sets and remote monitoring equipment (if applicable) at the site within a response period of less than (eight hours or appropriate time period designated for Project) from time of notification.
 - 1. The transfer switch shall be serviced by technicians employed by, and specially trained and certified by, the generator set supplier and the supplier shall have a service organization that is factory-certified in both generator set and transfer switch service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.
 - 2. Submit names, experience level, training certifications, and locations for technicians that will be responsible for servicing equipment at this site.
 - 3. The manufacturer shall maintain model and serial number records of each transfer switch provided for at least 20 years.
- B. **Source Limitations:** All transfer switches are to be obtained through one source from a single manufacturer. The generator set manufacturer shall warrant transfer switches to provide a single source of responsibility for products provided.
- C. **Electrical Components, Devices, and Accessories:** Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked as suitable for use in emergency, legally required or optional standby use as appropriate for the connected load.
- D. **The automatic transfer switch installation and application shall conform to the requirements of the following codes and standards:**
 - 1. Transfer switches and enclosures shall be UL 1008 listed and labeled as suitable for use in emergency, legally required, and optional standby applications.
 - 2. CSA 282, Emergency Electrical Power Supply for Buildings, and CSA C22.2, No. 14-M91 Industrial Control Equipment
 - 3. NFPA 70, National Electrical Code. Equipment shall be suitable for use in systems in compliance with Articles 700, 701 and 702.
 - 4. Comply with NEMA ICS 10-1993 AC Automatic Transfer Switches
 - 5. IEEE 446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
 - 6. EN55011, Class B Radiated Emissions and Class B Conducted Emissions
 - 7. IEC 1000-4-5 (EN 61000-4-5); AC Surge Immunity
 - 8. IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity
 - 9. IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity
 - 10. IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity
 - 11. IEC 1000-4-6 Conducted Field Immunity
 - 12. IEC 1000-4-11 Voltage Dip Immunity
 - 13. IEEE 62.41, AC Voltage Surge Immunity
 - 14. IEEE 62.45, AC Voltage Surge Testing

- E. Comply with NFPA 99 – Essential Electrical Systems for Healthcare Facilities
- F. Comply with NFPA 110 – Emergency and Standby Power Systems. The transfer switch shall meet all requirements for Level 1 systems, regardless of the actual circuit level.
- G. The manufacturer shall warrant the material and workmanship of the transfer switch equipment for a minimum of five (5) year from the warranty start date. The warranty start date is the date of registered commissioning and start up or eighteen (18) months from date of shipment, whichever is sooner.

1.4 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:
 - 1. Notify Owner no fewer than 14 days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.
 - 3. Do not energize any new service or distribution equipment without notification and permission of the Owner.

1.5 COORDINATION

- A. Size and location of concrete bases and anchor bolt inserts shall be coordinated. Concrete, reinforcement and formwork must meet the requirements specified in Division 03. See section "INSTALLATION" for additional information on installation

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cummins Power Generation
 - 2. Approved equals may be considered if equipment performance is shown to meet the requirements herein.
- B. Transfer switches utilizing molded case circuit breakers do not meet the requirements of this specification and will not be accepted.

Note: The same manufacturer shall be used for both the generator and transfer switch.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Provide transfer switches in the number and ratings that are shown on the drawings.

- B. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer.
- C. Fault-Current Closing and Withstand Ratings: UL 1008 WCR ratings must be specifically listed as meeting the requirements for use with protective devices at installation locations, under specified fault conditions. Withstand and closing ratings shall be based on use of the same set of contacts for the withstand test and the closing test.
- D. Solid-State Controls: All settings should be accurate to +/- 2% or better over an operating temperature range of - 40 to + 60 degrees C (- 40 to + 140 degrees F).
- E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- F. Electrical Operation: Accomplished by a non-fused, momentarily energized solenoid or electric motor operator mechanism, mechanically and electrically interlocked in both directions (except that mechanical interlock is not required for closed transition switches).
- G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. Switches using molded-case switches or circuit breakers, or insulated case circuit breaker components are not acceptable.
 - 2. Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in the Source 1 and Source 2 positions.
 - 3. Main switch contacts shall be high pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.
 - 4. Contacts shall be operated by a high-speed electrical mechanism that causes contacts to open or close within three electrical cycles from signal.
 - 5. Transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation but prevent direct contact with components that could be operating at line voltage levels.
 - 6. The transfer switch shall include the mechanical and control provisions necessary to allow the device to be field-configured for operating speed. Transfer switch operation with motor loads shall be as is recommended in NEMA MG1.
 - a. Phase angle monitoring/timing equipment is not an acceptable substitute for this functionality
 - 7. Transfer switches designated on the drawings as "service entrance" switches shall meet the requirements of section "SERVICE ENTRANCE TRANSFER SWITCHES" of this specification.
- H. Control: Transfer switch control shall be capable of communicating with the genset control, other switches and remote programming devices over a high-speed network interface.
- I. Factory wiring: Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism

- J. Terminals: Terminals shall be pressure type and appropriate for all field wiring. Control wiring shall be equipped with suitable lugs, for connection to terminal strips.
- K. Enclosures: All enclosures shall be third-party certified for compliance to NEMA ICS 6 and UL 508, unless otherwise indicated:
 - 1. The enclosure shall provide wire bend space in compliance to the latest version of NFPA70, regardless of the direction from which the conduit enters the enclosure.
 - 2. Exterior cabinet doors shall provide complete protection for the system's internal components. Doors must have permanently mounted key-type latches. Bolted covers or doors are not acceptable.
 - 3. Transfer switches shall be provided in enclosures that are third party certified for their intended environment per NEMA requirements.
 - a. Transfer switches located outdoors shall be supplied in NEMA Type 3R (IEC IP34) when dust-proof and/or rain-proof enclosures are required.

2.3 AUTOMATIC TRANSFER SWITCHES

- A. Comply with requirements for Level 1 equipment according to NFPA 110.
- B. Indicated current ratings:
 - 1. Refer to the Project drawings for specifications on the sizes and types of transfer switch equipment, withstand and closing ratings, number of poles, voltage and ampere ratings, enclosure type, and accessories.
 - 2. Main contacts shall be rated for 600 VAC minimum.
 - 3. Transfer switches shall be rated to carry 100% of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C (-40 to +140 degrees F), relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000 meters).
- C. Relay Signal: Control shall include provisions for addition of a pre-transfer relay signal, adjustable from 0 to 60 seconds, to be provided if necessary for elevator operation, based on equipment provided for the project.
- D. Transfer switches that are designated on the drawings as 3-pole shall be provided with a neutral bus and lugs. The neutral bus shall be sized to carry 100% of the current designated on the switch rating.
- E. Automatic Transfer Switch Control Features
 - 1. The transfer switch control system shall be configurable in the field for any operating voltage level up to 600 VAC. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions that are not field configurable are not acceptable.
 - 2. All transfer switch sensing shall be configurable from an operator panel or from a Windows XP or later PC-based service tool. Designs utilizing DIP switches or other electromechanical devices are not acceptable.
 - 3. The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device to prevent transfer to the generator service.
 - 4. The transfer switch shall provide a relay contact signal prior to transfer or re-transfer. The time period before and after transfer shall be adjustable in a range of 0 to 60 seconds.

5. The control system shall be designed and prototype tested for operation in ambient temperatures from - 40 degrees C to + 60 degrees C (- 40 to +140 degrees F). It shall be designed and tested to comply with the requirements of the noted voltage and RFI/EMI standards.
 6. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.
- F. Transfer Switch Control Panel: The transfer switch shall have a microprocessor-based control with a sealed membrane panel incorporating pushbuttons for operator-controlled functions, and LED lamps for system status indicators. The panel shall also include an alphanumeric display for detailed system information. Panel display and indicating lamps shall include permanent labels.
1. The indicator panel LEDs shall display:
 - a. Which source the load is connected to (Source 1 or Source 2)
 - b. Which source or sources are available
 - c. When switch is not set for automatic operation, the control is disabled
 - d. When the switch is in test/exercise mode
 2. The indicator shall have pushbuttons that allow the operator to activate the following functions:
 - a. Activate pre-programmed test sequence
 - b. Override programmed delays, and immediately go to the next operation
 - c. Reset the control by clearing any faults
 - d. Test all of the LEDs by lighting them simultaneously
 3. The alphanumeric digital display shall be vacuum fluorescent-type, clearly visible in both bright sunlight and no-light conditions over an angle of 120 degrees, and shall display the following:
 - a. AC voltage for all phases, normal and emergency
 - b. Source status: connected or not connected.
 - c. Load data, including voltage, AC current, frequency, KW, KVA, and power factor.
 4. The display panel shall be password-protected, and allow the operator to view and make adjustments:
 - a. Set nominal voltage and frequency for the transfer switch
 - b. Adjust voltage and frequency sensor operation set points
 - c. Set up time clock functions
 - d. Set up load sequence functions
 - e. Enable or disable control functions including program transition
 - f. View real-time clock data, operation log (hours connected, times transferred, failures) and service history
- G. Control Functions: Functions managed by the control shall include:
1. Software adjustable time delays:
 - a. Engine start (prevents nuisance genset starts in the event of momentary power fluctuation): 0 to 120 seconds (default 3 sec)
 - b. Transfer normal to emergency (allows genset to stabilize before load is transferred): 0 to 120 seconds (default 3 sec)
 - c. Re-transfer emergency to normal (allows utility to stabilize before load is transferred from genset): 0 to 30 minutes (default 3 sec)
 - d. Engine cooldown: 0 to 30 minutes (default 10 min)
 - e. Programmed transition: 0 to 60 seconds (default 3 sec)
 2. Voltage imbalance sensing:

- a. Dropout: 2 to 10% (default 4%)
 - b. Pickup: 90% of dropout
 - c. Time delay: 2.0 to 20 seconds (default 5 sec)
 3. Phase rotation sensing:
 - a. Time delay: 100 msec
 4. Loss of single-phase detection:
- H. Control features shall include:
 1. Programmable genset exerciser: A field-programmable control shall periodically start and run the generator with or without transferring the load for a preset time period, then re-transfer and shut down the generator after a preset cool-down period.
 2. In event of a loss of power to the control, all control settings, real-time clock setting and the engine start-time delay setting will be retained.
 3. The system continuously logs information including the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. An event recorder stores information, including time and date-stamp, for up to 50 events.
 4. Re-Transfer Inhibit Switch: Inhibits automatic re-transfer control so automatic transfer switch will remain connected to emergency power source as long as it is available regardless of condition of normal source.
 5. Transfer Inhibit Switch: Inhibits automatic transfer control so automatic transfer switch will remain connected to normal power source regardless of condition of emergency source.
- I. Control Interface
 1. Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.
 2. The transfer switch shall be provided with a network communication card, and configured to allow network-based communication with the transfer switch and other network system components, including the generator set(s) provided for the Project.
- J. Engine Starting Contacts
 1. One isolated and normally closed pair of contacts rated 10A at 32 VDC minimum.

2.4 SERVICE ENTRANCE TRANSFER SWITCHES

- A. Transfer switches must be specifically intended for service entrance applications, and labeled "Suitable for service entrance use only"
- B. Transfer switch shall meet NEC requirements for emergency, legally required and standby applications as specified in UL 1008.
- C. Entire transfer switch including enclosure must be listed and labeled to UL 1008; switches with only the mechanism listed are not acceptable.
- D. Molded case circuit breaker must be UL 489 listed with LI trip unit. "Long" setting to be adjusted to a maximum of 760 amps.

2.5 SOURCE QUALITY CONTROL

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 16 Section "Electrical Supports and Seismic Restraints."
- B. Floor-Mounting Switch: Anchor to floor by bolting.
 - 1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support.
- C. Identify components according to Division 16 Section "Electrical Identification."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

- A. Ground equipment according to Division 16 Section "Grounding and Bonding."
- B. Connect wiring according to Division 16 Section "Conductors and Cables."
- C. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- D. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.
- E. Transfer switch shall be provided with AL/CU mechanical lugs sized to accept the full output rating of the switch. Lugs shall be suitable for the number and size of conductors shown on the drawings.

3.3 SOURCE QUALITY CONTROL

- A. Prior to shipping, factory shall test and inspect components, assembled switches, and associated equipment to ensure proper operation.

- B. Factory shall check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements.
- C. Factory shall perform dielectric strength test complying with NEMA ICS 1.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: The supplier of the transfer switch and associated equipment shall inspect, test, and adjust components, assemblies, and equipment installations, including connections, and report results in writing.
- B. Manufacturer's representative shall perform tests and inspections and prepare test reports.
- C. After installing equipment and after electrical circuitry has been energized, installer shall test for compliance with requirements.
 - 1. Perform recommended installation tests as recommended in manufacturer's installation and service manuals.
 - 2. After energizing circuits, demonstrate interlocking sequence and operational function for each switch.
 - 3. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - 4. Verify time-delay settings.
 - 5. Verify that the transfer switch is accurately metering AC voltage and current.
 - 6. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
- D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- E. Remove and replace malfunctioning units and retest as specified above.
- F. Infrared Scanning by contractor: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
 - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
 - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

- B. Coordinate this training with that for generator equipment.
- C. After generator set installation, the generator and transfer switch supplier shall conduct a complete operation, basic maintenance, and emergency service seminar covering generator set and transfer switch equipment, for up to 10 people employed by the Owner.
 - 1. The seminar shall include instruction on operation of the transfer equipment, normal testing and exercise, adjustments to the control system, use of the PC based service and maintenance tools provided under this contract, and emergency operation procedures.
 - 2. The class duration shall be at least 8 hours in length, and include practical operation with the installed equipment.

END OF SECTION 16415

SECTION 16441 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes service and distribution switchboards rated 600 V and less.

1.2 SUBMITTALS

- A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 - a. Mimic-bus diagram.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NEMA PB 2, "Deadfront Distribution Switchboards."
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 MANUFACTURED UNITS

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Protection Div.
3. Siemens Energy & Automation, Inc.
4. Square D.

B. Front-Connected, Front-Accessible Switchboard: panel-mounted branches, and sections front and rear aligned.

C. Nominal System Voltage: 208Y/120 V.

D. Main-Bus Continuous: 800 A.

E. Enclosure: Steel, NEMA 250, Type 3R.

F. Enclosure Finish: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

G. Barriers: Between adjacent switchboard sections.

H. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

I. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

J. Pull Box on Top of Switchboard:

1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
2. Set back from front to clear circuit-breaker removal mechanism.
3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

K. Buses and Connections: Three phase, four wire, unless otherwise indicated with feeder circuit-breaker line connections.

1. Ground Bus: 1/4-by-2-inch- minimum-size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 2. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 3. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
 4. Neutral Buses: 50 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.
- L. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.3 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic trip-unit circuit breakers shall have RMS sensing, field-replaceable rating plug, and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 3. Enclosed, Insulated-Case Circuit Breaker: Fully rated, encased-power circuit breaker with interrupting capacity rating to meet available fault current.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install switchboards and accessories according to NEMA PB 2.1 and NECA 40.
- B. Install and anchor switchboards level on concrete bases, 4-inch nominal thickness.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- E. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section 16000.
- B. Switchboard Nameplates: Label each switchboard compartment with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

END OF SECTION 16441